Essential Pre-Uni Physics G3.5

GCSE C C C A Level P P P

- Specific heat capacity of water: $4180\,\mathrm{J\,kg^{-1}\,K^{-1}}$
- Specific heat capacity of aluminium: $880\,\mathrm{J\,kg^{-1}\,K^{-1}}$
- Specific heat capacity of iron: $435\,\mathrm{J\,kg^{-1}\,K^{-1}}$
- Specific heat capacity of paraffin oil: $2130\,\mathrm{J\,kg^{-1}\,K^{-1}}$

These specific heat capacities can also be found within the hint tabs.

A radiator is made using $5.4\,\mathrm{kg}$ of iron. It is then filled with $7.3\,\mathrm{kg}$ of water. Calculate its heat capacity, that is the heat required to raise the temperature of the whole thing per kelvin.

Essential Pre-Uni Physics G3.6

GCSE C C C A Level P P P

- Specific heat capacity of water: $4180\,\mathrm{J\,kg^{-1}\,K^{-1}}$
- Specific heat capacity of aluminium: $880\,\mathrm{J\,kg^{-1}\,K^{-1}}$
- Specific heat capacity of iron: $435\,\mathrm{J\,kg^{-1}\,K^{-1}}$
- Specific heat capacity of paraffin oil: $2130\,\mathrm{J\,kg^{-1}\,K^{-1}}$

These specific heat capacities can also be found within the hint tabs.

In the following questions, two substances are mixed. In each case work out the missing mass or temperature, assuming no heat is lost to the surroundings.

First substance			Second substance			Mixture
Material	m_1 / kg	t_1 / °C	**Material**	m_2 / kg	t_2 / °C	t_{mix} /°C
Water	3.2	83	Paraffin	4.3	18	**(a)**
Water	0.34	14	Iron	0.15	230	**(b)**
Water	1.25	56	Paraffin	**(c)**	170	84
Aluminium	3.2	12	Paraffin	2.1	**(d)**	51

Part A Final temperature (a)

First substance			Second substance			Mixture
Material	m_1 / kg	t_1 / °C	**Material**	m_2 / kg	t_2 / °C	t_{mix} /°C
Water	3.2	83	Paraffin	4.3	18	**(a)**

a) What is the final temperature of the mixture in °C?

Part B Final temperature (b)

First substance			Second substance			Mixture
Material	m_1 / kg	t_1 / °C	**Material**	m_2 / kg	t_2 / °C	t_{mix} /°C
Water	0.34	14	Iron	0.15	230	**(b)**

b) What is the final temperature of the mixture in °C?

Part C Mass of paraffin (c)

First substance			Second substance			Mixture
Material	m_1 / kg	t_1 / °C	**Material**	m_2 / kg	t_2 / °C	t_{mix} /°C
Water	1.25	56	Paraffin	**(c)**	170	84

c) What is the mass of paraffin in kg?

Part D Temperature of paraffin (d)

First substance			Second substance			Mixture
Material	m_1 / kg	t_1 / °C	**Material**	m_2 / kg	t_2 / °C	t_{mix} /°C
Aluminium	3.2	12	Paraffin	2.1	**(d)**	51

d) What is the initial temperature of the paraffin in °C?

Gameboard:

STEM SMART Physics 47 - Revision - Thermal Physics

Essential Pre-Uni Physics G4.3

GCSE C C C A Level P P P

- Specific heat capacity of water: $4180\,\mathrm{J\,kg^{-1}\,K^{-1}}$
- Specific heat capacity of ice: $2030\,\mathrm{J\,kg^{-1}\,K^{-1}}$
- Specific latent heat of fusion of ice: $3.35 \times 10^{5}\,\mathrm{J\,kg^{-1}}$
- Specific latent heat of vaporization of water: $2.26 \times 10^{6}\,\mathrm{J\,kg^{-1}}$

In all questions, assume that the heat capacities given above remain constant at all temperatures.

Calculate the ratio between the energy needed to vaporize a certain quantity of water, and the energy needed to heat that same quantity of water from the freezing point to the boiling point (without boiling it). Give your answer as a positive number greater than 1, to 3 significant figures.

Gameboard:

STEM SMART Physics 47 - Revision - Thermal Physics

Melting a Snowman

GCSE C C C A Level C C C

Two red LEDs are the eyes of an evil snowman, with a circuit inside its head. This question will allow you to work out how long it takes for the snowman to melt.

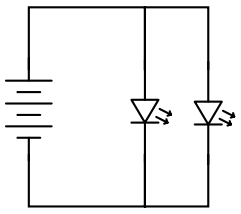

Figure 1: The circuit diagram for the snowman's eyes.

Part A Total power

The voltage across the battery is $6.0\,\mathrm{V}$ and the current drawn from the cell is $0.23\,\mathrm{A}$.

What is the total power produced by both LEDs?

Part B Mass of ice

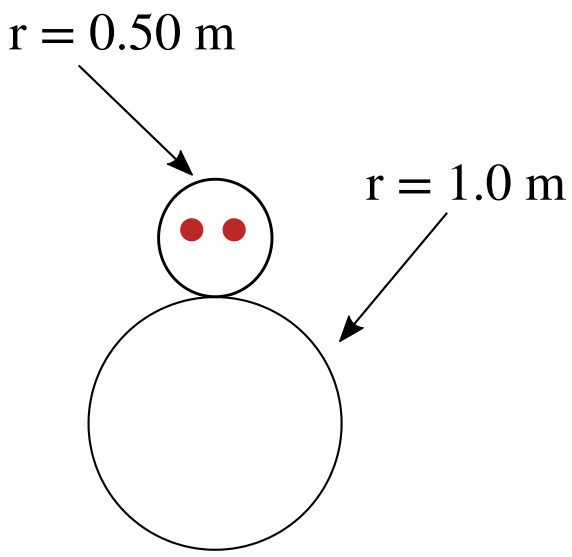

Figure 2: The snowman. The head and body are spherical with radii of $0.50\,\mathrm{m}$ and $1.0\,\mathrm{m}$ respectively.

The ice has a density of $930\,\mathrm{kg\,m^{-3}}$.

Work out the mass of ice in the snowman.

Part C Time taken to melt

The specific latent heat of fusion of ice is $335\,\mathrm{J\,g^{-1}}$. Assume that the snowman is at $0.0\,^{\circ}\mathrm{C}$ and the LEDs are $30\,\%$ efficient at converting electrical energy to light energy, with the remainder being converted to heat energy.

Calculate the time that it takes for all the ice in the snowman to melt due to the LEDs. Assume that the light emitted by the LEDs is not absorbed by the ice, and that all of the heat produced by the LEDs goes to melting the ice. Give your answer in years.

Created for isaacphysics.org by Vandan Parmar, Maria-Andreea Filip and Richard Simon

Gameboard:

STEM SMART Physics 47 - Revision - Thermal Physics

Essential GCSE Physics 1.6

Year 9 GCSE

Units with powers: please note that $1\,\mathrm{cm}^2$ means $1\,\mathrm{cm} \times 1\,\mathrm{cm} = 0.01\,\mathrm{m} \times 0.01\,\mathrm{m} = 10^{-4}\,\mathrm{m}^2$.

One litre $(1\,\mathrm{L}) = 10\,\mathrm{cm} \times 10\,\mathrm{cm} \times 10\,\mathrm{cm} = 1000\,\mathrm{cm}^3$. It is also equal to $0.1\,\mathrm{m} \times 0.1\,\mathrm{m} \times 0.1\,\mathrm{m} = 0.001\,\mathrm{m}^3 = 1\,\mathrm{dm}^3$.

Convert the following volumes to cubic metres (m^3).

Part A $2\,500\,\mathrm{cm}^3$

Convert $2\,500\,\mathrm{cm}^3$ into cubic metres (m^3).

Part B $68\,\mathrm{cm}^3$

Convert $68\,\mathrm{cm}^3$ into cubic metres (m^3).

Part C $3\,700\,\mathrm{litres}$

Convert $3\,700\,\mathrm{litres}$ into cubic metres (m^3).

Gameboard:
STEM SMART Physics 47 - Revision - Thermal Physics

Essential Pre-Uni Physics G2.4

GCSE P P P A Level P P P

Physical constants which may be necessary to answer the problems on this page can be found within the hint tabs.

Don't forget that one mole of gas contains 6.02×10^{23} molecules, and that the mass of this amount is called the 'molar mass'.

Complete the questions in the table, giving your answers to 2 significant figures unless stated otherwise.

P_1 / Pa	V_1 / cm^3	T_1 / K	P_2 / Pa	V_2 / cm^3	T_2 / K
1.01×10^5	30	300	(a)	20	300
1.01×10^5	30	300	(b)	30	373
1.01×10^7	2	600	1.01×10^5	(c)	300
1.01×10^5	500	(d)	1.01×10^7	10	4

Part A Final pressure (a)

P_1 / Pa	V_1 / cm^3	T_1 / K	P_2 / Pa	V_2 / cm^3	T_2 / K
1.01×10^5	30	300	(a)	20	300

a) What is the pressure in Pa?

Part B Final pressure (b)

P_1 / Pa	V_1 / cm^3	T_1 / K	P_2 / Pa	V_2 / cm^3	T_2 / K
1.01×10^5	30	300	(b)	30	373

b) What is the pressure in Pa?

Part C Final volume (c)

P_1 / Pa	V_1 / cm^3	T_1 / K	P_2 / Pa	V_2 / cm^3	T_2 / K
1.01×10^7	2	600	1.01×10^5	(c)	300

c) What is the volume in cm^3?

Part D Initial temperature (d)

P_1 / Pa	V_1 / cm^3	T_1 / K	P_2 / Pa	V_2 / cm^3	T_2 / K
1.01×10^5	500	(d)	1.01×10^7	10	4

d) What is the temperature in K to 1 significant figure?

Gameboard:

STEM SMART Physics 47 - Revision - Thermal Physics

Essential Pre-Uni Physics G2.7

GCSE P P P A Level C C C

Physical constants which may be necessary to answer the problems on this page can be found within the hint tabs.

Don’t forget that one mole of gas contains 6.02×10^{23} molecules, and that the mass of this amount is called the ‘molar mass’.

A water fire extinguisher contains about four litres of air at $10^7\,\mathrm{Pa}$ and $20\,^\circ\mathrm{C}$. When the extinguisher is used, this gas forces the water out. Calculate the pressure when the volume has increased to ten litres and the temperature has dropped to about $3.0\,^\circ\mathrm{C}$. Give your answer to 2 significant figures.

Gameboard:

STEM SMART Physics 47 - Revision - Thermal Physics

Gas Laws, Density and Kinetic Energy 32.4

A Level

What is the density of a gas at a pressure of $150\,\mathrm{kPa}$ if the mean-square speed of the particles is $9.0 \times 10^4\,\mathrm{m^2\,s^{-2}}$?

Gameboard:

STEM SMART Physics 47 - Revision - Thermal Physics

Gas Laws, Density and Kinetic Energy 32.3

A Level

Use your answers to question 32.1, or your knowledge of gas laws, to complete the following table containing information on different gases: (give your answers to 2 significant figures)

Chemical formula	**Molecular mass** / u	**Temperature** / K	**Pressure** / kPa	**Density** / $\mathrm{kg\,m^{-3}}$
NO_2	46	500	115	(a)
HCl	36.5	(b)	120	277
NH_3	17	723	(c)	57.3

Part A Density

Chemical formula	**Molecular mass** / u	**Temperature** / K	**Pressure** / kPa	**Density** / $\mathrm{kg\,m^{-3}}$
NO_2	46	500	115	(a)

Find the density (a). Give your answer to 2 significant figures.

Part B Temperature

Chemical formula	Molecular mass / u	Temperature / K	Pressure / kPa	Density / $\mathrm{kg\,m^{-3}}$
HCl	36.5	(b)	120	277

Find the temperature (b). Give your answer to 2 significant figures.

Part C Pressure

Chemical formula	Molecular mass / u	Temperature / K	Pressure / kPa	Density / $\mathrm{kg\,m^{-3}}$
$\mathrm{NH_3}$	17	723	(c)	57.3

Find the pressure (c). Give your answer to 2 significant figures.

Gameboard:

STEM SMART Physics 47 - Revision - Thermal Physics

Gas Laws, Density and Kinetic Energy 32.7

A Level

Calculate the temperature at which the mean molecular kinetic energy is $1.60 \times 10^{-21}\,\mathrm{J}$.