A-level Physics
Summer Independent Learning
Y12-13

Part 1: Compulsory work (pages 2 to 28)

Part 2: Strongly recommended work (page 28)

Welcome to Y13 A Level Physics, please complete the following tasks ready for your first day back at New College. You can either write on the document electronically, print the document out or write your notes and answers on paper to bring in for your first lesson in September.

You may have to **research** any knowledge or techniques you cannot immediately recall using common GCSE resources or other tutorials.

Please be aware that you will have an **assessment** on these topics shortly after beginning your A level Physics course and the knowledge covered is essential to understanding the subsequent content

Part 1: Compulsory

This work will form the first part of your Year 13 Physics studies – Thermal Physics and gas Laws.

Revise your knowledge and understanding of Temperature and energy changes from GCSE using BBC Bitesize:

Temperature change and energy including (link): States of matter, Internal energy Energy and temperature Specific heat capacity Specific latent heat Multiple changes	
Particles in gases including (link): Particle motion Pressure and temperature Pressure and volume Work and energy	

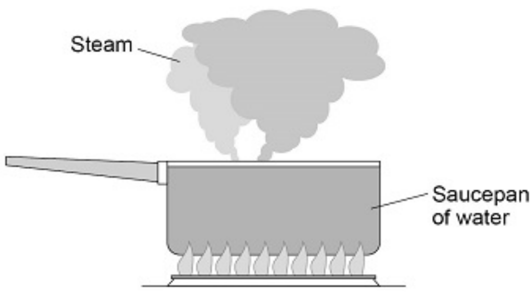
Use your revision to answer, mark and correct the following GCSE questions.

The mark scheme is at the end of the questions.

Q1.

Figure 1 shows water being heated. Eventually the water changed into steam.

Figure 1



(a) Complete the sentences.

Choose answers from the box.

Each answer may be used once, more than once or not at all.

greater than	**less than**	**the same as**

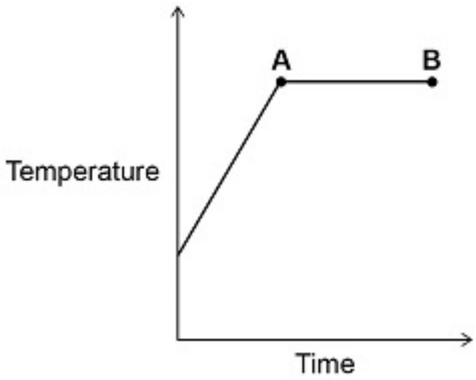
The distance between the particles in steam is ____________________________ the distance between the particles in liquid water.

The density of steam is ____________________________ the density of liquid water.

(2)

Figure 2 shows how the temperature of the water varied with time.

Figure 2



(b) What is the name of the process that is taking place between points **A** and **B**?

Give a reason for your answer.

Process ____

Reason ____

____

(2)

(c) A mass of 0.063 kg of water was turned into steam.

The specific latent heat of vaporisation of water is 2 260 000 J/kg

Calculate the thermal energy transferred to the water to turn it into steam.

Use the equation:

thermal energy for a change of state = mass ×specific latent heat

____

____

____

Energy = ______________________ J

(2)

(d) The mass of the steam was 0.063 kg

The volume of the steam was 0.105 m^3

Calculate the density of steam.

Use the equation:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

Choose the unit from the box.

kg	**m^3 / kg**	**kg / m^3**

____

____

____

Density = ______________________ Unit ______________

(3)

(Total 9 marks)

Q2.

A student investigated the thermal conductivity of different metals.

This is the method used:

1. Measure the mass of an ice cube.
2. Put the ice cube on a metal block which is at room temperature.
3. Measure the mass of the ice cube after one minute.
4. Repeat with other blocks of the same mass made from different metals.

The following table shows the student's results.

Metal	**Initial mass of ice cube in grams**	**Final mass of ice cube in grams**	**Change in mass of ice cube in grams**
Aluminium	25.85	21.14	4.71
Copper	26.20	20.27	5.93
Lead	25.53	21.97	3.56
Steel	24.95	19.45	5.50

(a) The initial temperature of each ice cube was –15 °C

Why was it important that the initial temperature of each ice cube was the same?

Tick (✓) **one** box.

Initial temperature was a continuous variable.	☐
Initial temperature was a control variable.	☐
Initial temperature was the dependent variable.	☐
Initial temperature was the independent variable.	☐

(1)

(b) Which metal had the highest thermal conductivity?

Give a reason for your answer.

Metal: ____

Reason: ____

____

____

(2)

(c) Suggest **one** source of random error in the student's investigation.

____

____

____

____

(1)

(d) An ice cube has a temperature of −15.0 °C

The total thermal energy needed to raise the temperature of this ice cube to 0.0 °C and completely melt the ice cube is 5848 J

specific heat capacity of ice = 2100 J/kg °C

specific latent heat of fusion of ice = 334 000 J/kg

Calculate the mass of the ice cube.

____

____

____

____

____

____

____

____

Mass of ice cube = ____________________ kg

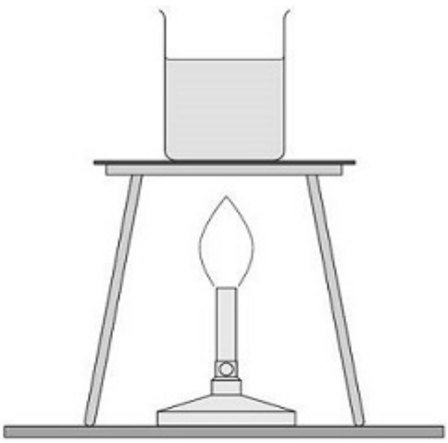
(5)

(Total 9 marks)

Q3.

The figure below shows a Bunsen burner heating some water in a beaker.

Eventually the water changes into steam.



(a) Explain how the internal energy of the water changes as it is heated from 20 °C to 25 °C

___

___

___

___

(2)

(b) How is the particle model used to explain the difference in density between a liquid and a gas?

Tick (✓) **one** box.

Particles in a gas have less kinetic energy than particles in a liquid.	☐
Particles in a gas have more potential energy than particles in a liquid.	☐
Particles in a liquid are further apart than particles in a gas.	☐
Particles in a liquid are larger than particles in a gas.	☐

(1)

(c) A student measured the mass of boiling water that was turned into steam in five minutes.

Explain how the student could use this information to estimate the power output of the Bunsen burner in watts.

___

___

___

___

___

___

____

____

____

(4)

(Total 7 marks)

Q4.

The diagram below shows a cyclist riding along a flat road.

(a) Complete the sentence.

Choose answers from the box.

chemical	**elastic potential**	**gravitational potential**	**kinetic**

As the cyclist accelerates, the ________________________ energy store in the cyclist's body decreases and the ________________________ energy of the cyclist increases.

(2)

(b) The mass of the cyclist is 80 kg. The speed of the cyclist is 12 m/s.

Calculate the kinetic energy of the cyclist.

Use the equation:

$$\text{kinetic energy} = 0.5 \times \text{mass} \times (\text{speed})^2$$

____

____

Kinetic energy = ____________________ J

(2)

(c) When the cyclist uses the brakes, the bicycle slows down.

This causes the temperature of the brake pads to increase by 50 °C.

The mass of the brake pads is 0.040 kg.

The specific heat capacity of the material of the brake pads is 480 J/kg °C.

Calculate the change in thermal energy of the brake pads.

Use the equation:

change in thermal energy = mass × specific heat capacity × temperature change

Change in thermal energy = ____________________ J

(2)

(d) How is the internal energy of the particles in the brake pads affected by the increase in temperature?

Tick **one** box.

Decreased	☐
Increased	☐
Not affected	☐

(1)

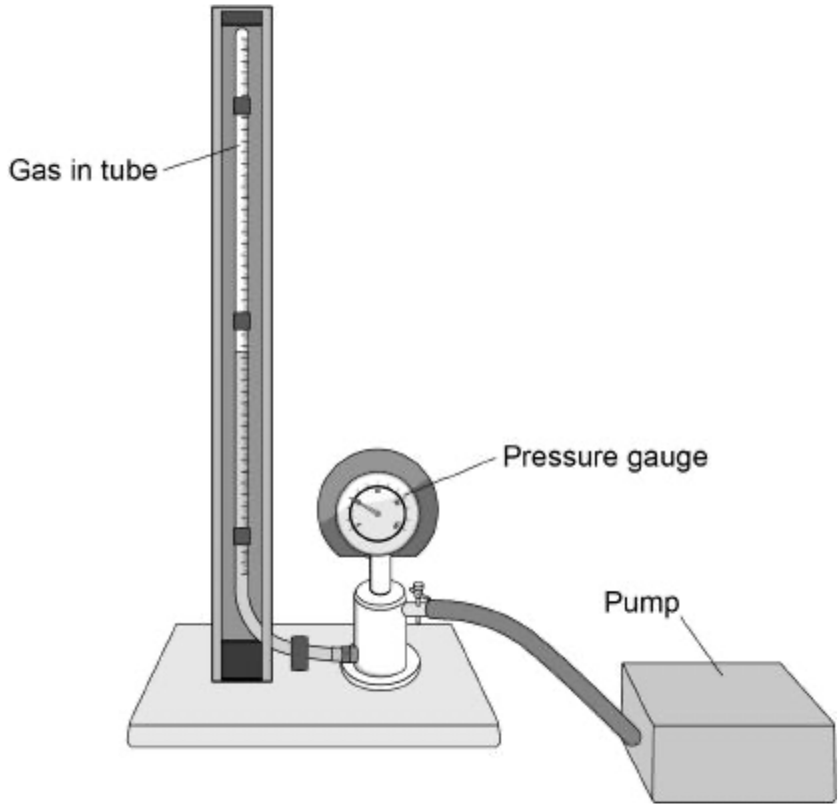
(Total 7 marks)

Q5.

A student investigated how the pressure exerted by a gas varied with the volume of the gas.

Figure 1 shows the equipment the student used.

Figure 1



A pump was used to compress the gas in a tube. As the volume of the gas decreases, the pressure of the gas increases.

(a) The student only recorded one set of results.

Give **two** reasons why taking repeat readings could provide more accurate data.

1. ____

____

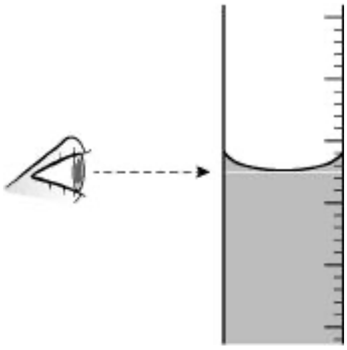
2. ____

____

(2)

(b) **Figure 2** shows the position of the student's eye when taking volume measurements.

Figure 2



Explain what type of error would be caused if the student's eye was **not** in line with the level of the liquid in the tube.

(2)

(c) If the gas is compressed too quickly the temperature of the gas increases.

Explain how the temperature increase would affect the pressure exerted by the gas.

(2)

(d) One of the student's results is given below.

pressure = 1.6×10^5 Pa

volume = 9.0 cm^3

Calculate the volume of the gas when the pressure was 1.8×10^5 Pa.

The temperature of the gas was constant.

Volume = ______________________ cm^3

(3)

(e) **Figure 3** shows a person using a bicycle pump to inflate a tyre.

Figure 3

The internal energy of the air increases as the tyre is inflated.

Explain why.

___

___

___

___

(2)

(Total 11 marks)

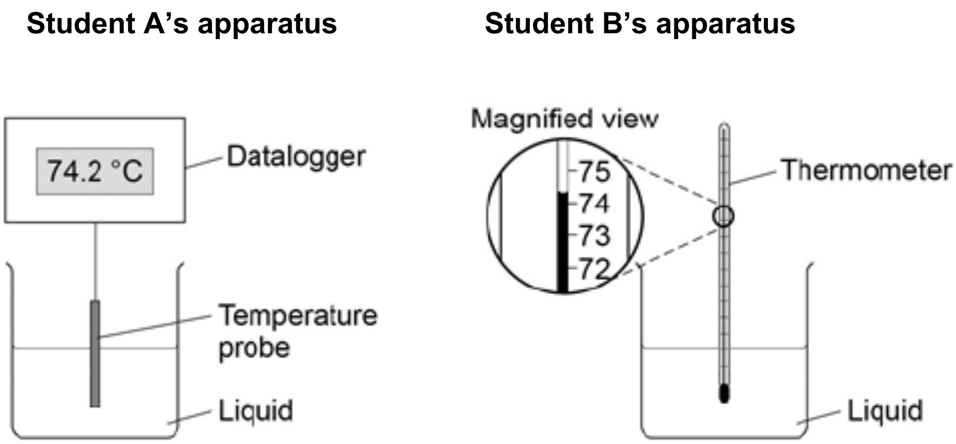
Q6.

Two students investigated the change of state of stearic acid from liquid to solid.

They measured how the temperature of stearic acid changed over 5 minutes as it changed from liquid to solid.

Figure 1 shows the different apparatus the two students used.

Figure 1



(a) Choose **two** advantages of using student **A**'s apparatus.

Tick **two** boxes.

Student **A**'s apparatus made sure the test was fair. ☐

Student **B**'s apparatus only measured categoric variables. ☐

Student **A**'s measurements had a higher resolution. ☐

Student **B** was more likely to misread the temperature. ☐

(2)

(b) Student **B** removed the thermometer from the liquid each time he took a temperature reading.

What type of error would this cause?

Tick **one** box.

A systematic error ☐

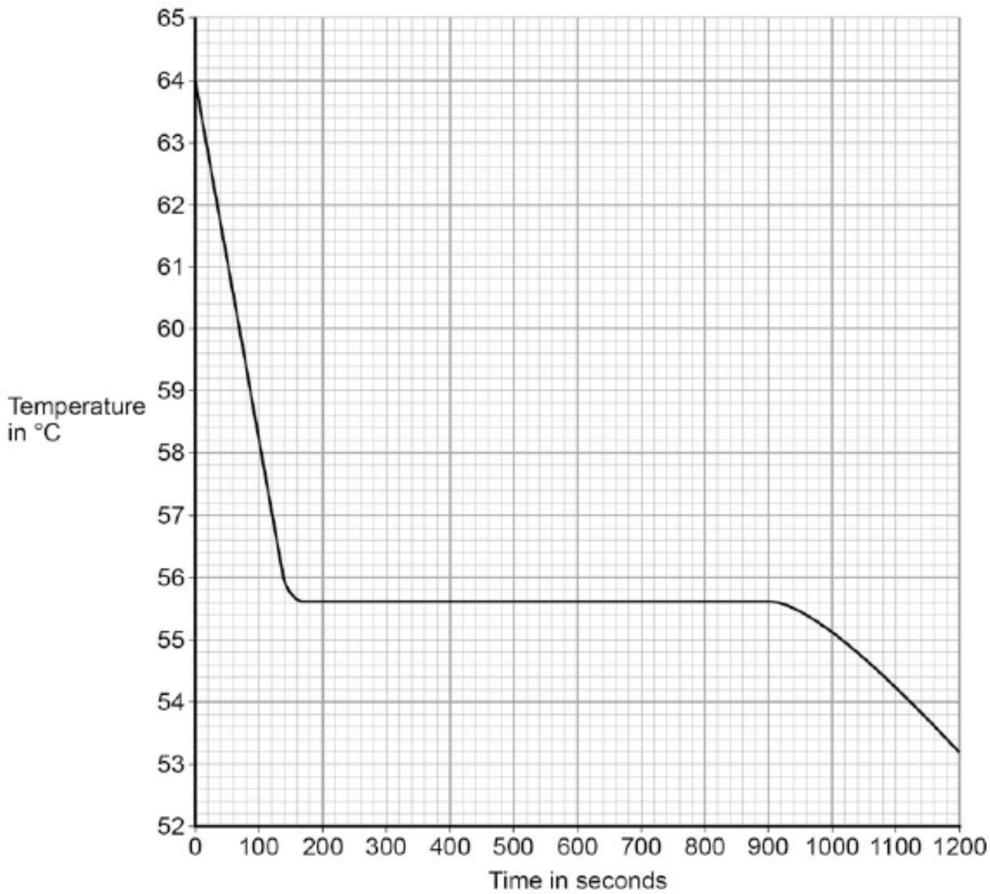
A random error ☐

A zero error ☐

(1)

(c) Student **A**'s results are shown in **Figure 2**.

Figure 2



What was the decrease in temperature between 0 and 160 seconds?

Tick **one** box.

8.2 °C ☐

8.4 °C ☐

53.2 °C ☐

55.6 °C ☐

(1)

(d) Use **Figure 2** to determine the time taken for the stearic acid to change from a liquid to a solid.

Time = ____________ seconds

(1)

(e) Calculate the energy transferred to the surroundings as 0.40 kg of stearic acid changed state from liquid to solid.

The specific latent heat of fusion of stearic acid is 199 000 J / kg.

Use the correct equation from the Physics Equations Sheet.

____

____

____

Energy = ____________________ J

(2)

(f) After 1200 seconds the temperature of the stearic acid continued to decrease.

Explain why.

___

___

___

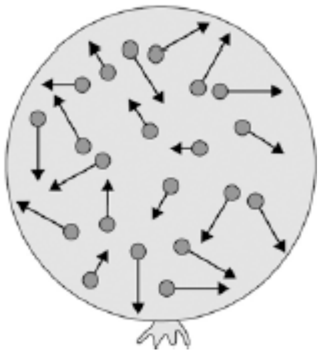
___

(2)

(Total 9 marks)

Q7.

The figure below shows a balloon filled with helium gas.



(a) Describe the movement of the particles of helium gas inside the balloon.

___

___

___

___

(2)

(b) What name is given to the total kinetic energy and potential energy of all the particles of helium gas in the balloon?

Tick **one** box.

External energy ☐

Internal energy ☐

Movement energy ☐

(1)

(c) Write down the equation which links density, mass and volume.

____

(1)

(d) The helium in the balloon has a mass of 0.00254 kg.

The balloon has a volume of 0.0141 m^3.

Calculate the density of helium. Choose the correct unit from the box.

m^3 / kg	**kg / m^3**	**kg m^3**

____

____

____

____

Density = ____________________ Unit __________

(3)

(Total 7 marks)

Answers to GCSE exam questions:

Q1.

(a) greater than

1

less than

1

in this order only

(b) <u>boiling</u>

ignore evaporation

1

temperature is constant

allow temperature remains the same

1

(c)

*a correct answer that rounds to 140 000 (J) scores **2** marks*

E = 0.063 × 2 260 000

1

E = 140 000 (J)

allow 142 380 (J)

1

(d)

*an answer of 0.6 scores **2** marks*

$$\text{density} = \frac{0.063}{0.105}$$

1

density = 0.6

1

kg / m^3

1

[9]

Q2.

(a) Initial temperature was a control variable

1

(b) copper

1

greater change in mass (than the other metals)

this mark is dependent on scoring the first mark

allow more ice melted (than the other metals)

allow the ice melted faster (than the other metals)

1

(c) variation in initial mass of ice cube

allow variation in initial volume of ice cube

or

surface area of the ice cube touching the metal

allow melting of ice while handling

allow variation in room temperature

allow initial temperature of metal block

1

(d)

*an answer of 0.016 (kg) scores **5** marks*

E = m × 2100 × 15

1

E = m × 334 000

1

5848 = 31 500 m + 334 000 m

or

5848 = 365 500 m

1

$$m = \frac{5848}{(31\,500 + 334\,000)}$$

or

$$m = \frac{5848}{(365\ 500)}$$

1

m = 0.016 (kg)

*allow **2** marks for an answer that rounds to 0.186 or 0.0175*

*if no other mark scored allow **1** mark for either*

5848 = m × 2100 × 15

or

5848 = m × 334 000

1

[9]

Q3.

(a) the (mean) kinetic energy of the particles increases

allow the (mean) speed of the particles increases

'kinetic energy increases' is insufficient by itself

*do **not** accept particles vibrating*

1

which increases the (internal) energy of the water

ignore description of evaporation

1

(b) Particles in a gas have more potential energy than particles in a liquid.

1

(c) Energy given to water E = mL with quantities defined

1

$$\text{power output (of Bunsen burner)} = \frac{\text{energy transferred (to water)}}{\text{time}}$$

allow $P = \frac{E}{t}$ *with quantities defined*

1

$$\text{power output} = \frac{\text{change in mass} \times \text{specific latent heat}}{\text{time}}$$

allow E = Pt equated with E = mL or stated in words

or

$P = \frac{mL}{t}$ *with quantities defined*

1

time should be converted to seconds

or

use a time of 300 seconds

1

[7]

Q4.

(a) chemical

1

kinetic

1

in this order only

(b) $E_k = 0.5 \times 80 \times 12^2$

1

$E_k = 5760$ (J)

1

*an answer of 5760 (J) scores **2** marks*

(c) E = 0.040 × 480 × 50

1

E = 960 (J)

1

*an answer of 960 (J) scores **2** marks*

(d) increased

1

[7]

Q5.

(a) any **two** from:

- calculate a mean
- reduces the effect of random errors

  reduces human error is insufficient
- identify / remove anomalies

  allow to assess the repeatability of the data

2

(b) random error

allow a parallax error

human error is insufficient

1

(because) eye position would not be the same each time (relative to the liquid)

allow systematic error only if it is clear that the student always viewed liquid level from above meniscus (or below)

1

(c) (a temperature increase would) increase the pressure in the tube

(even if the volume was constant)

1

(because a higher temperature would mean) higher (average) kinetic energy of molecules / particles

allow higher (average) speed for higher (average) kinetic energy

1

(d) $1.6 \times 10^5 \times 9.0$ (= 1.44×10^6)

1

$1.44 \times 10^6 = 1.8 \times 10^5 \times V$

*allow for **2** marks*

$$V = \frac{1.6 \times 10^5 \times 9.0}{1.8 \times 10^5}$$

1

or

$$V = \frac{1.44 \times 10^6}{1.8 \times 10^5}$$

V = 8.0 (cm^3)

1

*an answer of 8.0 (cm^3) scores **3** marks*

(e) work is done on the air (in the tyre)

1

so the temperature (of the air) increases

allow the (average) kinetic energy of the particles increases

1

[11]

Q6.

(a) Student A's measurements had a higher resolution

1

Student B was more likely to misread the temperature

1

(b) a random error

1

(c) 8.4 °C

1

(d) 740 (seconds)

allow answers in the range 730 – 780

1

(e) 0.40 × 199 000

1

79 600 (J)

1

*accept 79 600 (J) with no working shown for **2** marks*

(f) stearic acid has a higher temperature than the surroundings

accept stearic acid is hotter than the surroundings

1

temperature will decrease until stearic acid is the same as the room temperature / surroundings

1

[9]

Q7.

(a) range of speeds

1

moving in different directions

accept random motion

1

(b) internal energy

1

(c) density = mass / volume

1

(d) 0.00254 / 0.0141

1

0.18

1

*accept 0.18 with no working shown for the **2** calculation marks*

kg / m^3

1

[7]

Part 2: Compulsory

Use the Oxford textbook available here: https://tinyurl.com/vk2ya868

Let the page load for a minute – the file is quite large.

Use the pages outlined below to answer the following questions:

19.1 Internal Energy and Temperature - pages 306 – 309.

Q1. When does energy transfer between two objects take place?
Q2. State the two ways to increase the internal energy of an object.
Q3. What must be happening if the internal energy of an object is constant?
Q4. Write out the first law of thermodynamics.
Q5. Describe the movement of molecules in a solid.
Q6. What happens to the molecules of a solid when temperature increases?
Q7. What does the energy supplied to melt a solid do to the molecules?
Q8. Describe the movement of molecules in a liquid.
Q9. Describe the movement of molecules in a gas.
Q10. What is the definition of internal energy?
Q11. If internal energy flows from water to your hand what do we know about their temperatures?
Q12. When are two objects in thermal equilibrium?
Q13. What is the lowest possible temperature on the Celsius scale?
Q14. What are 0 °C and 100 °C on the absolute scale (in kelvin)?
Q15. What is meant by absolute zero?

Now answer the summary questions on page 309.

19.2 Specific Heat Capacity – pages 310 - 312

Q1. What is meant by the specific heat capacity of a substance?
Q2. What is the unit of specific heat capacity?
Q3. How is the energy needed to change temperature calculated? Define all terms in the equation.
Q4. What is the assumption when using an inversion tube?
Q5. Describe or draw the experimental set up used to find the specific heat capacity of a solid.
Q6. What is the assumption when carrying out this experiment?
Q7. How is the specific heat capacity of a solid calculated from this set up? Define all terms in the equation.
Q8. Does the change in temperature need to be calculated in Celsius or kelvin?
Q9. When finding the specific heat capacity of a liquid what does the electrical energy supply increase the temperature of?
Q10. If we are given volume flow rate, what else do we need to be given to calculate the flow rate of mass?

Now answer the summary questions on page 312.

19.3 Change of State – pages 313 - 315

Q1. What happens when the temperature of a solid increase?
Q2. What happens when the temperature of a liquid increase?
Q3. What happens when a solid is heated at its melting point?
Q4. What does latent mean?
Q5. What happens when a liquid is heated at its boiling point?
Q6. Which state changes require energy?
Q7. Which state changes release energy?
Q8. What is sublimation?
Q9. Compare the energy required to vaporise a substance with the energy required to melt it.
Q10. What is meant by the specific latent heat of fusion?
Q11. What is meant by the specific latent heat of vaporisation?
Q12. How is the energy needed to change state calculated? Define all terms in the equation.
Q13. What is the unit of specific latent heat?
Q14. What happens to the temperature of a solid as it melts?
Q15. In a temperature-tine graph what is the gradient equal to?

Now answer the summary questions on page 315.

20.1 The Experimental Gas Laws – pages 318 – 319.

Q1. What is the pressure of a gas?
Q2. What is the unit of pressure?
Q3. What is an isothermal change?
Q4. State Boyle's law.
Q5. Which quantities have constant values?
Q6. How else can Boyle's law be written?
Q7. What measurements need to be taken to find absolute zero?
Q8. What is the volume of a gas at absolute zero?
Q9. How are the measurements used to find the value of absolute zero?
Q10. State Charles' law
Q11. Which quantities have constant values?
Q12. What is an isobaric change?
Q13. How is the work done in changing the volume of a gas calculated? Define all terms in the equation.
Q14. What is the pressure law?
Q15. Which quantities have constant values?

Now answer the summary questions on page 319.

20.2 The Ideal Gas Law – pages 320 - 322

Q1. What is the pressure of a gas on a surface due to?
Q2. What is Brownian motion?
Q3. What does Brownian motion show the existence of?
Q4. What is the Avogadro constant?
Q5. What is the value of the Avogadro constant?
Q6. What is meant by one mole of a substance?
Q7. What is meant by the molar mass of a substance?
Q8. What is the unit of molar mass?
Q9. How is the number of moles of a substance calculated? Define all terms in the equation.

Q10. How is the number of molecules of a substance calculated? Define all terms in the equation.
Q11. What is an ideal gas?
Q12. If a graph of pV (y-axis) against T (x-axis) is plotted, what is the gradient of the graph equal to?
Q13. What is the ideal gas equation? Define all terms in the equation.
Q14. What is the other version of the ideal gas equation? Define all terms in the equation.
Q15. What is the unit of temperature in both of the above equation?

Now answer the summary questions on page 322.

20.3 The Kinetic Theory of Gases – pages 323 - 326

Q1. What does empirical mean?
Q2. Why does reducing the volume increase the pressure of a gas (at constant temperature)?
Q3. Why does increasing the temperature increase the pressure of a gas (in a constant volume)?
Q4. Copy figure 1 and describe what it shows.
Q5. What happens to the speed of the molecules in a gas if the temperature is increased?
Q6. Write out the kinetic theory equation. Define all terms in the equation.
Q7. What are the assumptions made about the molecule (which lead to the kinetic theory equation)?
The derivation will be covered in lesson
Q8. For an ideal gas, what is the internal energy equal to?
Q9. How in the mean kinetic energy of a molecule of an ideal gas calculated? Define all terms in the equation.
Q10. How is the total kinetic energy of gas moles of molecules found?

Now answer the summary questions on page 326.

Strongly recommended summer learning

Go to Teams and then to To the Alevel Physics resources team, then to files and then to the folder called Y12 – 13 SIL (link).

Answer, mark and correct the 2 exam papers in the folder.