RADLEY

Scholarship Examination

# Physics

March 2016

Time allowed – 90 minutes for all three science papers

Calculators are not to be used

Total marks available = 33

Most of the marks in these questions are for showing how well you think. Your final answers are less important than demonstrating a logical and systematic approach.

You must show your working out at all stages and clearly state any assumptions that you make.

Where you can, use powers of ten to show very big or very small numbers. For example 1,000,000 can be written: $1.0 \times 10^6$

**Clouds**

December 2015 was very mild and very rainy. This question will guide you through a few calculations to help you to understand more about clouds and rainfall. Clouds are formed from many tiny droplets of water. Scientists have measured the amount of water in air and the graph on the back page shows these results. You will need it to answer the next few questions.

1. Describe in words what the graph on the back page shows and comment its shape **[2]**

2. The graph shows the mass of water in one cubic kilometre of cloud. One cubic kilometre is the volume of a cube with sides 1 km long. What is 1 cubic kilometre in $m^3$? **[2]**

3. Study the graph on the back page and answer the following questions (NB: 1 tonne = 1000 kg)

   a. At 0°C what is the water content of one cubic kilometre of cloud? Give your answer in tonnes and also in kg. **[2]**

   b. At 20°C what is the water content of one cubic kilometre of cloud. Give your answer in tonnes and also in kg. **[2]**

   c. What is the <u>percentage</u> increase in water content when the temperature rises from 0°C to 20°C. **[3]**

Here is an excerpt from a UK weather website:

> *31 December 2015 - Record breaking rainfall in December puts 2015 in the top ten wettest years on records going back to 1910*
>
> *Latest early provisional statistics from the Met Office confirm December has been record breaking both for its warmth and rainfall. The UK mean temperature (1-29 December) is a record breaking 8.0 °C which is 4.1 °C above the long-term average. The previous record was 6.9 °C in 1934.*

4. Use the temperatures in the text above to explain why December in the UK was so wet. You should use numbers from the graph on the back page to support your answer **[5]**

5. The water droplets in a cloud have an average radius of 0.002 mm.

   a. What is the radius of an average water droplet in metres? **[2]**

   b. The water droplets are spherical. The approximate volume of a sphere is given by the formula:

   Approximate volume of a sphere = 4 x radius$^3$ or in symbols $V = 4r^3$

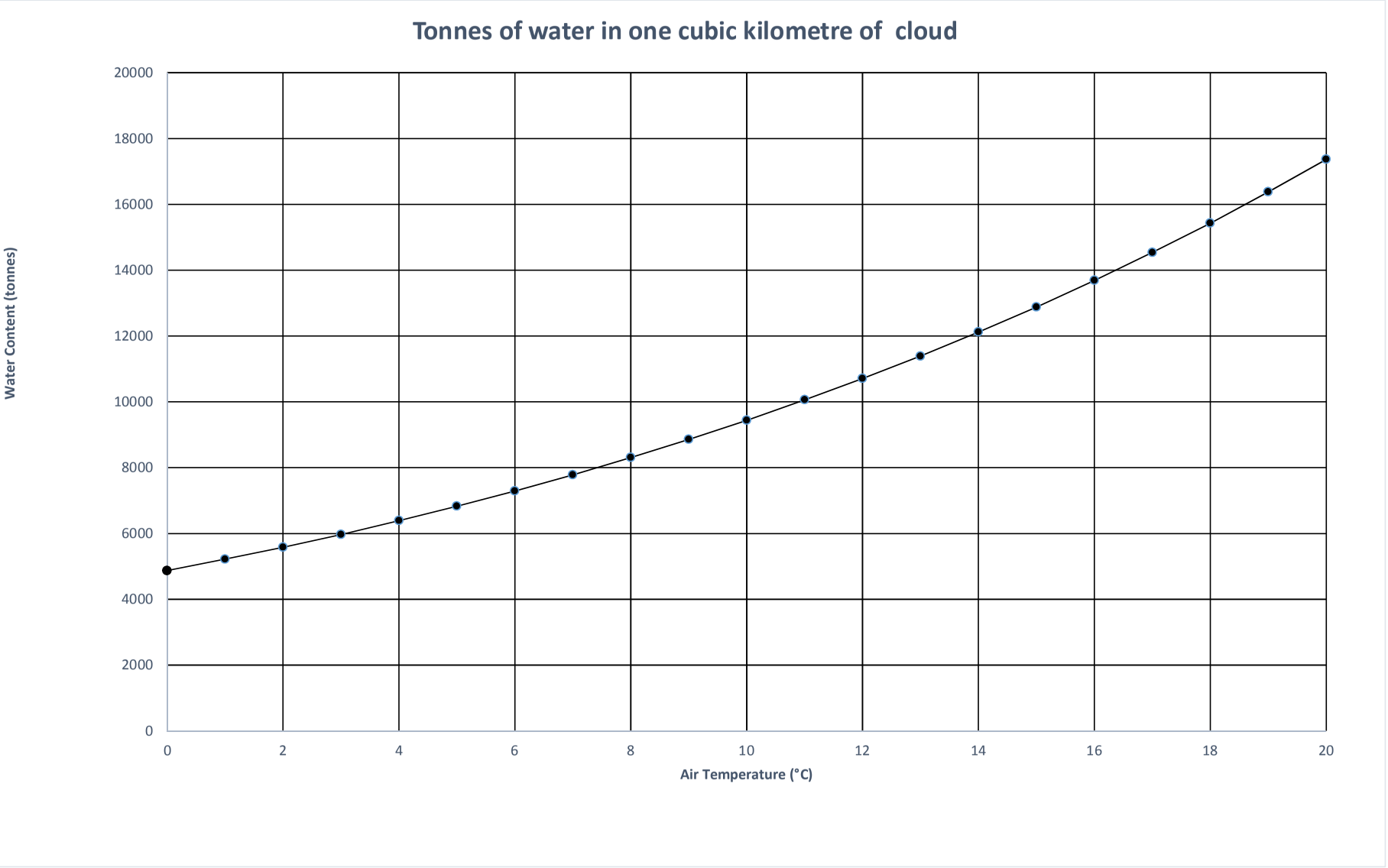
   Calculate the volume of an average water droplet in m$^3$ **[5]**

6. The mass of an average water droplet in a cloud is $3.0 \times 10^{-14}$ kg. How many such water droplets would there be in 3kg of water? **[3]**

7. The mass of an average water droplet in a cloud is $3.0 \times 10^{-14}$ kg. How many such water droplets would there be in 3kg of water? **[3]**

8. It is now raining very heavily and you want to get from one building at your school to another. This involves being outside for a distance of about 200m. One of your friends thinks that you will get wetter if you run. Another friend thinks that walking takes longer and so will mean that you get wetter. Who do think is right and why? **[4]**

With thanks to Michael de Podesta for the blog post which inspired this question and for the spreadsheet data. https://protonsforbreakfast.wordpress.com/2015/12/30/just-how-mild-has-this-december-been/


Tonnes of water in one cubic kilometre of cloud
Water Content (tonnes)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
2
4
6
8
10
12
14
16
18
20
Air Temperature (°C)