# Topical Applications of Mathematics

## Old New Year — TEACHER INFORMATION

**Key Stage** 3

**Target** Pupils of any ability, but really aimed at Y7 pupils.

***MEP* references** Year 8, Unit 12

**Teaching notes** This would be particularly topical to use in early January! It is, though, of interest at any time and the algorithm used in Activity 7 should be of interest to all pupils of any age or ability.

The resource shows that mathematics is a lively and relevant subject, needed to help solve real world problems.

For average ability pupils, you could set the problem of how to cope with adjusting the Julian calendar so that there is not (over several thousand years) a problem of the seasons becoming out of step with the date. You could also set the task of explaining *why* the algorithm works.

The resource can also be used to encourage pupils to recognise that there are other calendars in use around the world and that these calendars, with their religious connections, are just as relevant to those who use them as our Christian-based calendar is to us.

**Solutions and Notes** for material in the Pupil Text

Many of the Activities are either research questions that need to be set prior to the lesson or discussion activities for the whole class.

### *Activity 1*

The websites

http://en.wikipedia.org/wiki/Julian_calendar

and

http://en.wikipedia.org/wiki/Gregorian_calendar

are among the many that give helpful information.

### *Activity 2*

| | | |
|---|---|---|
| Julian year | = 365.2500 | days |
| Actual year | = 365.2422 | days |
| difference | = 0.0078 | days per year |

(This is equivalent to 0.1872 hours, or about 11 minutes, per day!)

### *Activity 3*

Birds migrating; agriculture - bulbs/crops flowering/growing; animals breeding, etc.

### *Activity 4*

Under the Gregorian calendar, every 400 years has not 100 leap years, but 97.

Hence

$$\begin{aligned} \text{Gregorian year} &= 365\frac{97}{400} \approx 365.2425 \text{ days} \\ \text{Actual year} &= 365.2422 \text{ days} \\ \text{Difference} &= 0.0003 \text{ days per year} \end{aligned}$$

This will not cause a problem for some time as the gain is less than 30 seconds per day!

### *Activity 5*

As 2100 will not be a leap year, the date will change to January 14th in 2101.

Thereafter, it will change in only 3 out of 4 century years, so that the dates of the Old New Year will be

January 14th 2101 → 2200
January 15th 2201 → 2300
January 16th 2301 → 2500
January 17th 2501 → 2600, etc.

### *Activity 6*

The following websites give information about various calendars. There are many other sources of information.

http://webexhibits.org/calendars/year.html

http://charon.nmsu.edu/~lhuber/leaphist.html

### *Activities 7 and 8*

Practical activities for pupils.

### *Activity 8*

You will need a further term in $S$ by calculating $\left[\frac{Y-1}{400}\right]$ and taking this off the value of $S$.

The following formula allows for leap years in century years only when they are divisible exactly by 400 (e.g. 2000, 2400, etc.):

$$S = D + Y + \left[\frac{Y-1}{4}\right] - \left[\frac{Y-1}{100}\right] + \left[\frac{Y-1}{400}\right] \quad S = D + Y + \left[\frac{Y-1}{4}\right] - \left[\frac{Y-1}{100}\right] + \left[\frac{Y-1}{400}\right]$$

with the KEY, remainder 0 is SATURDAY, 1 is SUNDAY, etc.

# Topical Applications of Mathematics

## Old New Year — SAMPLE LESSON PLAN

| *Activity* | | *Notes* |
|---|---|---|
| | | T: Teacher P: Pupil |
| **1** | **January 13th**<br>T: Do you know what is significant about this day? *(New Year's Day in the Russian Orthodox Church)*<br>T: Why is 'Old New Year' celebrated on this date?<br>T: What calendar do we use? *(Gregorian calendar)*<br>T: How does it work? *(365 days each year with an extra day in February every 4th (leap) year)*<br>T: The Julian calendar was used from about 45 BC. It had a leap year every 4 years, so what was the average length of a year? *(365.25 days)*<br>T: How long does it take for the Earth to rotate around the Sun?<br>T: About 365.2422 days. Does it matter that this is not exactly the same length as an average year? *(Not in the short term)*<br>T: What about after 1000 years? *(It might make a difference)*<br>T: What will the difference be after one year? *(0.0078 days)*<br>T: How many minutes per year is this? *(* $0.0078 \times 24 = 0.1872$ *hours)*<br>T: 11 minutes as $0.1872 \times 60 \approx 11$ minutes.<br>T: After 1000 years, how long will this be? *(About 8 days)*<br>T: Does this matter? *(Yes – calendar now out of step with seasons)*<br><br>*15 mins* | Make this as interactive as possible. You could set some preparatory work on calendars.<br>Hopefully some Ps might have some positive ideas but, if not, you will need to give the information.<br>It might be worth checking that all Ps are familiar with the number of days per month. You can use the well known rhyme (see Data Sheet 1).<br><br>Encourage the use of decimal notation here: you should have on the board or IWB:<br>*Days*<br>Julian year 365.2500<br>Actual year 365.2422<br>difference 0.0078<br>Encourage Ps to work at board in front of class. Give Ps time to formulate a method; intervene if struggling but encourage Ps to think for themselves.<br>Check that all Ps are happy with $0.0078 \times 1000 = 7.8$ days<br>There are many reasons for concern about the calendar being out of step with the seasons (growing plants, birds migrating, animals breeding, etc.); eventually, summer would become winter! |

| *Activity* | | *Notes* |
|---|---|---|
| **2** | **Gregorian Calendar**<br>T: In 1582 Pope Gregory decreed that<br>▪ October 4th 1582 should be followed by October 15th<br>▪ only 1 in 4 century years would a be leap year, with 1600, 2000, 2400, etc. being leap years but 1700, 1800, 1900, 2100, not.<br>T: Working in pairs, check how accurate this calendar is.<br><br>T (after 5 minutes): Who can describe how they tackled this problem?<br>T: Does this difference matter?<br>*(Not really; only 3 days after 10 000 years)*<br><br>*30 mins* | This alteration to the calendar may not be known by all Ps so you need to ensure that they all understand what happened.<br><br>T should encourage, help and intervene if necessary (best to get Ps to describe their approach to the rest of the class) and ensure that progress is being made.<br><br>It is important that Ps realise that the length of a year is<br>$365\frac{97}{400}$ days<br>(as there are 97 leap years in every 400 years).<br><br>Again, encourage them to write the details in a table:<br>*Days*<br>Gregorian year 365.2425<br>Actual year 365.2422<br>difference 0.0003 |

| *Activity* | | *Notes* |
|---|---|---|
| **3** | **Day of the week**<br>T: Do you know which day of the week you were born on? | Hopefully there will be number of Ps in the class who know this. Choose one of these and use their birth date. |
| | T: Here is an algorithm to help us find out. We'll see how it works with _____'s birth date.<br>With my help, we can do the calculation on the board. | Give a brief definition of an algorithm (a set of mathematical instructions that must be followed in a fixed order, which will help to calculate the answer to a mathematical problem).<br>Work through the algorithm on the board with the class, getting Ps to give the numbers to be written in. Make sure that they understand each step. |
| | T: Now it's your turn. Use your own birth date: work in pairs so that you can check your working. | Give each P a copy of Data Sheet 2.<br>Allow 5 minutes for this activity but intervene when necessary. You might like to reinforce the use of the algorithm by going through another birth date (yours?) orr date in the past that has relevance to the Ps.<br>T monitors and helps where necessary. |
| | T: Let's check the whole class now to see which is the modal day.<br>*(Monday, Tuesday ... ?)*<br>*45 mins* | The rhyme 'Monday's Child' is shown on Data Sheet 3. This might be of interest to Ps, but be careful not to upset anyone!! |
| **4** | **Homework**<br>1. Use the algorithm with a member of your family to find the day of the week for a specific birthday or family occasion.<br>2. How can this algorithm be adapted to work for any date? | |