OCR
Oxford Cambridge and RSA

Wednesday 07 October 2020 – Afternoon

Level 3 Certificate Core Maths A (MEI)

H868/01 Introduction to Quantitative Reasoning

Insert

Time allowed: 2 hours

8258168771

INSTRUCTIONS
- Do **not** send this Insert for marking. Keep it in the centre or recycle it.

INFORMATION
- This Insert contains the pre-release material that you have already seen.
- This document has **8** pages.

A Measuring happiness

For the last twenty years many governments and organisations have measured the happiness of their citizens or employees. Measurement methods usually involve asking subjects how happy they felt the previous day on a scale of, say, 0 to 10. Asking about the previous day ensures that subjects take an overall view, rather than focusing on something good or bad that perhaps happened just an hour or so ago. These questions are usually part of a larger questionnaire given by telephone about general well-being. Gallup carry out a worldwide survey every year. It involves thousands of interviewees (subjects).

The happiness index

The interviewer must follow a script when carrying out a well-being survey. Fig. A.1 shows part of a typical script:

Next I would like to ask you four questions about your feelings on aspects of your life. There are no right or wrong answers. For each of these questions I'd like you to give an answer on a scale of 0 to 10, where 0 is 'not at all' and 10 is 'completely'.

To Measure	Question
Life Satisfaction	*Overall, how satisfied are you with your life nowadays?*
Worthwhile	*Overall, to what extent do you feel that the things you do in your life are worthwhile?*
Happiness	*Overall, how happy did you feel yesterday?*
Anxiety	*On a scale where 0 is "not at all anxious" and 10 is "completely anxious", overall, how anxious did you feel yesterday?*

Source: Office for National Statistics (UK)

Fig. A.1

The Office for National Statistics (ONS) publish the resulting scores for happiness in four bands to give an overall picture of happiness levels in the UK. The meanings given to individual responses to the happiness questions are shown in the four bands in Fig. A.2.

Happiness rating	Happiness level
0 to 4	Low
5 to 6	Medium
7 to 8	High
9 to 10	Very high

Fig. A.2

The happiness score for a country is the mean of the individual values obtained in the survey.

The misery index

The **misery index** gives a rough summary of the economic situation for the average person in a country. The larger the misery index the worse the economic situation. The **misery index** is the sum of the annual **unemployment rate** and the annual **inflation rate**.

- **unemployment rate** is the percentage of the workforce who are unemployed,
- **inflation rate** is the percentage increase in prices of goods and services people buy.
- In 2000, the UK unemployment rate was 5.5% and the inflation rate was 0.8%.
  So the misery index was $5.5 + 0.8 = 6.3$; it is a number not a percentage.

In 1932 the US unemployment rate was 23.6% with an inflation rate of −13.3% (prices fell!). These figures give a misery index of $23.6 + (-13.3) = 10.3$.

Happy and sad words

Recent methods to measure happiness use the number of happy or sad words used in social media. Psychologists use the term **valence** to sum up the happy or sad emotions felt by people when using a particular word. About 10 000 words have been given a valence value. This is the mean value calculated after asking a large number of people how they felt about a particular word on a scale from 1 (completely unhappy) to 9 (very happy).

Fig. A.3 shows 12 of the 10 000 or so words to which valences have been assigned.

Word	Valence
Terrific	8.16
Hug	8.00
Swamp	5.14
Muddy	4.44
Fault	3.43
Nasty	3.38

Word	Valence
Rat	3.02
Alone	2.41
Headache	2.02
Afraid	2.00
Ulcer	1.78
Infection	1.66

Fig. A.3

So "Terrific gig but headache afterwards my fault for standing too near", has the mean valence or happy value of $(8.16 + 2.02 + 3.43) \div 3 = 4.54$ correct to 3 significant figures. (Notice that only the words which have valence values are used in calculating the mean valence of a text; other words are ignored.) A value of 5 is taken as being neither happy nor unhappy but neutral. So the text above shows slight unhappiness as a terrific gig is offset by fault and headache.

Computers allow the investigation of millions of social media texts in a short time. They also permit extending the list of words whose valence values have been found, for example happiest, happier as well as just happy, and text abbreviations e.g. idc (I don't care) or obvs (obviously).

There are many applications of valence. Newspapers and books have been analysed, by computer, to measure happiness/unhappiness several hundred years ago. Work has been done by psychologists using valences of people's spoken and written words to investigate depression. Some governments analyse the valence of words on social media to make themselves aware of possible social issues in their countries.

B Glaciers and icebergs

Glaciers grow from snow which has collected over time and turned into ice. Fresh snow only has a density of about 50 kilograms per cubic metre. Ice is quite dense, a cubic metre of ice has a mass of 920 kilos.

Fig. B.1 is a photograph of Perito Moreno Glacier in Argentina.

Fig. B.1

Glaciers flow slowly under their own weight, like a very sticky fluid. They have been called frozen rivers that flow. The speed of glaciers' movement can be measured using a Global Positioning System (GPS).

There is another method that can be used to measure the movement of glaciers. Fig. B.2 shows a rod with a wheel at one end. This is called a **trundle wheel**.

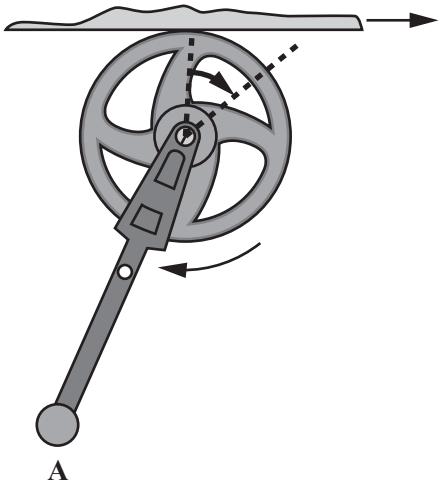

Fig. B.2

The end of the rod, A, is attached to a stationary rock face.
The wheel rests on the glacier and turns, without slipping as the glacier moves.

For example, a wheel of diameter 50 cm makes one complete turn.
This means that the glacier has moved by a distance of once round the outside of the wheel.
This distance, the circumference of the wheel, is calculated using $\pi \times$ its diameter.
So the glacier has moved a distance of $\pi \times 50\,\text{cm}$.

Suppose the same trundle wheel rotates through an angle of, say, 47°.
The fraction of the circumference of the trundle wheel moved by the glacier is $\left(\frac{47}{360}\right)$.
Therefore the glacier has moved a distance given by $\left(\frac{47}{360}\right) \times \pi \times 50 = 20.5\,\text{cm}$ (3sf).

A short clip showing the method in use may be found at
https://www.youtube.com/watch?v=njTjfJcAsBg

Icebergs are floating masses of ice that have broken away from a glacier or ice shelf. They are found in the oceans surrounding Antarctica, in the seas of the Arctic, in Arctic fjords, and in lakes fed by glaciers.

Fig. B.3

For many years there have been plans to tow icebergs, which are fresh water, to countries where there is not enough fresh water. Although the icebergs will partially melt, calculations show that enough ice could arrive at the destination. In the 1850s sailing boats were used to tow small icebergs from Alaska to California for their ice. The most suitable icebergs for towing are tabular icebergs like the one shown in Fig. B.3. These are approximately cuboidal in shape. About 90% of the height of a tabular iceberg is under water.

When dealing with very large volumes of water it is sometimes easiest to work with volume units of cubic kilometres (km^3). For example, the volume of water stored in the earth's icebergs, glaciers, snow and ice caps is estimated to be 45 million km^3.

BLANK PAGE

BLANK PAGE