

INSTITUTE AND FACULTY OF ACTUARIES

EXAMINATION

22 September 2020 (am)

Subject CM1B – Actuarial Mathematics Core Principles

Time allowed: One hour and forty-five minutes

In addition to this paper you should have available the 2002 edition of the Formulae and Tables and your own electronic calculator from the approved list.

If you encounter any issues during the examination please contact the Examination Team on T. 0044 (0) 1865 268 873.

- 1** A life insurance company issued a 20-year with-profits endowment assurance policy with a basic sum assured of £30,000 to a life aged 30 exact on 1 January 2000. Premiums of £1,000 per annum were payable annually in advance throughout the term of the policy or until earlier death.

To determine the amount of terminal bonus payable at maturity for this policy, the company calculated the gross premium reserve based on actual experience. The level of terminal bonus was set such that the total benefit payable on maturity was equal to this gross premium reserve.

The company does not pay a terminal bonus on the death of the policyholder. Death benefits are payable at the end of the year of death.

The company does not add any reversionary bonuses on its with-profits policies.

The assumptions to use for this question are set out in the 'Q1 Base' worksheet of the Excel answer workbook.

- (i) Construct, using a recursive approach, a schedule showing the gross premium reserve for each policy year of this policy. [17]
- (ii) Determine the terminal bonus rate that would be payable at maturity for this policy, expressed as a percentage of basic sum assured. [4]
- [Total 21]

- 2** An inflation index is set out in the 'Q2 Base' worksheet of the Excel answer workbook.

- (i) Calculate the annual effective inflation rate over the previous 12 months for each month from January 2004 to December 2019 using the index values provided. [4]

An investor purchased \$10 million nominal of a newly issued 15-year index-linked security on 15 January 2004, at a price of \$100 per \$100 nominal. The security paid coupons half-yearly in arrears at a nominal rate of 1.5% per annum and was redeemed at par.

The coupons and the redemption payment of the security were indexed in line with the inflation index values allowing for a three-month time lag.

- (ii) Calculate, assuming the investor held the security until redemption,
- (a) the annual effective money yield.
- (b) the annual effective real yield.

You may assume that all months are of equal length. [16]

- (iii) Assess the inflation protection that has been provided by the security. [6]
- [Total 26]

- 3** A life insurance company issues a deferred annuity contract to a life aged 55 exact. The annuity starts once the policyholder survives to age 70 exact with payments of £10,000 made annually in advance and ceasing on death.

Premiums are payable annually in advance from policy outset. The last premium is payable on the policy anniversary before the start of the deferred annuity payments.

The assumptions to use for this question, as well as details of death and surrender benefits, are set out in the 'Q3 Base' worksheet of the Excel answer workbook.

- (i) Show that the cost to the life insurance company of providing this annuity benefit at age 70 is approximately £135,000. [7]
- (ii) Calculate the annual premium the company should charge for this policy. [34]

The company is considering introducing an early retirement option, whereby policyholders are given the option to start receiving a reduced annuity benefit before age 70.

- (iii) Discuss the implications to the company of allowing policyholders to start receiving their benefits at age 65. [12]
- [Total 53]

END OF PAPER