PART III

Instructions for Part III

(i) *You should attempt* **ONLY ONE QUESTION** *from this part.*

(ii) *Write your answer in the answer book(s) provided.*

(iii) *All questions in this part carry equal marks.*

(iv) *If you are sure that there is something that you do not wish the examiner to mark, cross it out. It will then be ignored totally.*

(v) *You are advised to spend no more than* **40 minutes** *on Part III, which carries 20% of the total marks for the examination.*

(vi) *More credit will be given for a well constructed essay than for a mere succession of notes. Avoid complicated mathematical expressions.*

Q.3–1 Give *concise* accounts of **TWO** of the following topics, using equations and diagrams where appropriate.

(i) The *Stern–Gerlach experiment*. Describe the experiment, the results and their significance.

(ii) The *matrix representation of quantum mechanics*. Describe briefly the matrix representation of states, observables and the outcome of measurements using *either* spin *or* the simple harmonic oscillator as illustrations.

(iii) The *rotational–vibrational levels of a diatomic molecule*. You should include a mention of the assumptions and approximations that lead to the formula

$$E_{n,J} \simeq \left(n + \tfrac{1}{2}\right)\hbar\omega_0 + \frac{J(J+1)\hbar^2}{2\mu r_0^2}$$

and explain how an estimate of the internuclear separation might be made.

Q.3–2 Write an essay describing the *Coulomb model of the hydrogen atom*. In your essay, you should

- state the assumptions underlying the model.
- give a brief description of the steps involved in the solution of the time-independent Schrödinger equation.
- describe the predictions of the model concentrating on the wave function, angular momentum and energy.
- discuss the agreement between the predictions of the model and experiment.

You should not give detail of mathematical derivations, but you may include key mathematical equations and diagrams.
