

spectrophotometry as described previously<sup>1</sup>. In all cases adenine was formed in high yield. Some unreacted 4-aminoimidazole-5-carboxamide was observed in the acid and neutral reaction mixtures, but none in the basic reaction mixture. The experiment has been repeated recently at lower temperatures, and similar results have been obtained.

Although alternative mechanisms cannot yet be ruled out, the evidence obtained in my laboratory as well as recent evidence on the so-called 'one-step' synthesis of purines<sup>7</sup> supports the imidazole pathway outlined in Fig. 1 as a mechanism for the synthesis of adenine from hydrogen cyanide under possible primitive Earth conditions.

Work is being carried out at present on the isolation of the three-carbon compounds assumed to be the precursors of the 4-amino-5-substituted imidazoles isolated, and also on the synthesis of other purines from hydrogen cyanide.

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### A New Phase formed by High-Pressure Treatment: Face-centred Cubic Molybdenum Monocarbide

THE attempted preparation and retention of polymorphs dependent on pressure is an important area of high-pressure research. Some of these phases are found in Nature; others were unknown prior to the recent development of equipment suitable for research at high pressure and high temperature.

Although high-pressure phases are thermodynamically unstable at ambient conditions, a few have been retained by quenching to room temperature under pressure. High-pressure polymorphs found in the Earth's crust<sup>1</sup> include several minerals, for example, the pyroxene jadeite, NaAlSi<sub>2</sub>O<sub>6</sub> (ref. 2); kyanite, Al<sub>2</sub>SiO<sub>5</sub> (ref. 3); and diamond (ref. 4). Previously unknown phases are coesite<sup>5</sup>, a form of SiO<sub>2</sub> with a higher density than quartz; borazon<sup>6</sup>, a cubic form of boron nitride; and several compounds of the garnet type<sup>1</sup>. A number of high-pressure polymorphs of pure metals, which unlike the above compounds cannot be retained at ambient conditions, have been reported<sup>7</sup>.

High-pressure experiments on the molybdenum-carbon system have revealed a new form for the monocarbide phase. The new form, designated  $\alpha$ -MoC, has been retained to atmospheric pressure. Synthesis was achieved from both an equiatomic mixture of molybdenum and carbon and an equi-

atomic mixture of the compound Mo<sub>3</sub>C and carbon at pressures and temperatures in the range of 40–70 kilobars and 1,800°–2,500° C. The X-ray diffraction pattern for  $\alpha$ -MoC showed the first ten lines for a face-centred cubic structure. No additional lines were observed. The average lattice parameter was  $a_0 = 4.27$  Å. In addition to high-pressure experiments in which the only product was  $\alpha$ -MoC, other experiments carried out at lower temperatures and pressures afforded evidence for all the phases reported<sup>8</sup> for the molybdenum-carbon system at atmospheric pressure. A summary of the lattice parameters of the various phases is given in Table 1.

Table 1. COMPOSITION AND DIMENSIONS OF PHASES IN THE MOLYBDENUM-CARBON SYSTEM

Com-position	Symbol	Structure	X-ray data			Molybdenum atoms/unit cell
			$a_0$ (Å.)	$c_0$ (Å.)	$c_0/a_0$	
Mo <sub>3</sub> C	$\beta$	hexagonal closest packing	3.002	4.724	1.574	2
MoC	$\gamma$	hexagonal	2.898	2.809	0.969	1
MoC	$\gamma'$	hexagonal	2.932	10.97	3.742	4
MoC	$\eta$	complex hexagonal closest packing	3.00	14.58	4.86	6
MoC	$\alpha$	face-centred cubic (sodium chloride)	4.27	—	—	4

Further experimental detail and a thermodynamic analysis of the effect of pressure on the equiatomic region of the molybdenum-carbon system will be published elsewhere.

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### Generation of Radicals in Pairs and the Kinetics of Radical Chain Reactions in Solution

FREE radicals responsible for the propagation of chain reactions are commonly formed by the photochemical or thermal decomposition of an appropriate labile substance, and are, in such cases, inevitably produced in pairs. The restricted mobilities of radicals in solution have some special influence on the fate of these radicals, in that many pairs of radicals recombine before bringing about any reaction<sup>1</sup>. This effect,