

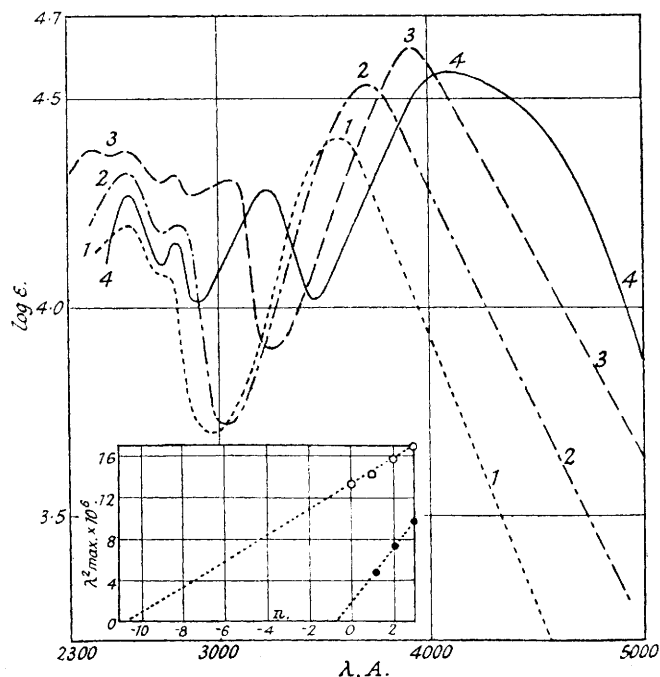
128. Studies in Light Absorption. Part II. 2:4-Dinitrophenylhydrazones.

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The visible and the ultra-violet light absorption properties of some fifty dinitrophenylhydrazones have been determined in both alcoholic and chloroformic solution. These properties are dependent upon the extent of the conjugated unsaturation present in the parent carbonyl compound, and alkyl substitution effects have also been observed (see Table II). The classified data provide structural evidence useful in degradative work and are of considerable theoretical interest in connection with the optical properties of the $>\text{C}=\text{N}-$ and the $>\text{NH}$ group.

EXTENSIVE data are already available regarding the light absorption of several classes of carbonyl derivative, particularly the semicarbazones, phenylsemicarbazones, thiosemicarbazones, and oximes (Burawoy, J., 1941, 20; Evans and Gillam, J., 1943, 565). The derivatives most widely used at present, however, for the characterisation of carbonyl compounds are the 2:4-dinitrophenylhydrazones, first introduced by Brady (*Analyst*, 1926, 51, 77). A comprehensive collection of light-absorption data for these compounds appeared desirable

FIG. 1.



1. Acetaldehyde. 2. Crotonaldehyde. 3. 3-Methylsorbaldehyde. 4. Octatrienal.
 $\bigcirc = (\text{C}=\text{C})_n \cdot \text{C}=\text{N} \cdot \text{NHX}$. $\bullet = (\text{C}=\text{C})_n \cdot \text{CHO}$.

Light absorption of 2:4-dinitrophenylhydrazones in chloroform solution.

for purely practical purposes, since preliminary studies had shown that the wave-length position of the main maximum in the extinction curve varied significantly with the degree of conjugated unsaturation of the parent carbonyl compound (Jones, Wilkinson, and Kerlogue, J., 1942, 735). It was subsequently found that the correlation between structure and light absorption in this series is much closer than was anticipated, and is of considerable theoretical interest with regard to the optical properties of the $>\text{C}=\text{N}-$ and $>\text{NR}$ groups.

In degradative work leading to aldehydic or ketonic products, it is often possible to isolate sufficient quantities of the water-insoluble dinitrophenylhydrazones for spectrographic examination when the isolation of the carbonyl compound itself is impracticable. The colour of the crystalline derivative provides a rough but not absolutely reliable indication of the degree of unsaturation of the parent compound, usually varying from yellow in the case of saturated aldehydes and ketones to dark red in the case of the triply unsaturated aldehyde octatrienal. Very much more precise information can now be obtained from a comparison of the light-absorption curve with the data given in Table II.

Data for the light-absorption maxima of some fifty 2:4-dinitrophenylhydrazones in the 2200–5000 Å. range are collected in Table I. As far as possible solutions in both alcohol and chloroform were examined within the limitations imposed by solubility and availability of material. With chloroform solutions the extinction curves cannot be followed below 2300 Å. because of the absorption of the solvent. Principal (long wave-length) bands are given in heavy type and are summarised in Table II.

TABLE I.
Light absorption of 2 : 4-dinitrophenylhydrazones.

Carbonyl compound.*	Solvent: EtOH.†		Solvent: CHCl ₃ .†	
	$\lambda_{\max.}, \text{A.}$	$\epsilon_{\max.} \times 10^{-2}.$	$\lambda_{\max.}, \text{A.}$	$\epsilon_{\max.} \times 10^{-2}.$
H·CHO (166°)	2250 2560 3480	185 120 230	2580 2800 3480	120 80 230
Me·CHO (167°)	2280 2560 3600	170 140 215	2570 2790 3600	155 105 250
Et·CHO (156°)	2280 2560 2780 3570	160 130 90 215	2520 2800 3610	140 120 210
Pr ^a ·CHO (107°)	2230 2560 3560	160 125 220	2580 3580	130 220
<i>n</i> -C ₆ H ₁₃ ·CHO (107°)	2280 2560 2800 3560	145 110 75 205	2560 2790 3580	135 80 200
COMe ₂ (128°)	2280 2550 3620	185 135 215	2580 2790 3660	125 105 225
COMeEt (115°)	2280 2550 3620	200 145 230	2580 2800 3650	115 75 220
COMePr ^a (145°)	2280 2550 2800 3620	210 155 80 250	2600 2800 3680	115 95 225
COMeBu (<i>n</i>) (108°)	2280 2560 2810 3620	180 95 40 175	2560 2790 3650	100 70 195
COEt ₂ (155°)	2290 2510 2780 3620	190 135 85 220	2550 2790 3660	165 125 250
COMe·CH ₂ ·CH ₂ ·CH·CMe ₂ (125°)	2280 2560 2800 3650	160 105 75 205	2570 2800 3670	135 115 210
COMe·CH ₂ ·CH ₂ ·CO ₂ H (205°)	—	—	2620 2780 3650	125 70 230
H·CO·CH ₂ ·CO ₂ H (150°) ¹	2280 2560 3500	130 115 200	2560 3510	110 195
COMe·CH ₂ ·CO ₂ H (125°) ¹	2280 2560 3580	175 105 205	2560 3600	110 205
<i>cyclo</i> Pentanone (146°)	2280 2550 2800 3630	170 140 80 225	2580 2790 3670	125 90 245
<i>cyclo</i> Hexanone (162°)	2280 2550 2800 3630	170 145 80 235	2550 2800 3660	130 95 245
Menthone (144°)	—	—	2600 2790 3650	185 125 255
Ketone (293°) ²	—	—	2420 2580 2810 3680	200 180 140 240
Sitostanone (209°) ³	—	—	2550 2810 2910 3680	180 140 100 255
Ph·CH(OH)·COMe (174°)	2280 2560 3670	145 155 240	2560 2810 3700	150 115 220


* M. p.'s of dinitrophenylhydrazones given in parentheses.

† Principal bands in heavy type.

TABLE I (contd.).
 Light absorption of 2:4-dinitrophenylhydrazones.

Carbonyl compound.	Solvent: EtOH.		Solvent: CHCl ₃ .	
	$\lambda_{\max.}, \text{A.}$	$\epsilon_{\max.} \times 10^{-2}$	$\lambda_{\max.}, \text{A.}$	$\epsilon_{\max.} \times 10^{-2}$
COMe·CO ₂ H (219°)	2420	105	2420	120
	2560	105	2560	120
	3550	225	3600	225
COEt·CO ₂ H (191°) ¹	2280	120	2420	125
	2430	125	2520	125
	2520	125	3650	255
	3640	235		
COPr ^{β} ·CO ₂ H (194°) ¹	2280	130	2450	180
	2430	130	2510	180
	2520	130	3660	250
	3660	240		
COMe·COPr ^{α} (107°)	2290	135	2560	130
	2560	115	2800	115
	3510	245	3520	260
COMe·CH ₂ ·CH ₂ ·COMe (bis) (257°)	—	—	2570	200
			3660	230
COMe·COEt (bis) (280°)	—	—	2560	230
			4000	440
			4400	365
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CH ₂ :CH·CHO (166°)	2280	150	2560	105
	2410	150	2820	80
	2510	150	3670	260
	2810	95		
	3660	255		
CHMe:CH·CHO (190°)	2440	180	2560	180
	2560	180	2810	135
	2800	120	3720	290
	3730	285		
CMe ₂ :CH·CHO (179°)	2560	185	2600	200
	2810	115	2960	155
	3810	285	3820	240
CHPr:CEt·CHO (123°)	2560	210	2570	170
	2800	160	2810	120
	3780	305	2920	85
			3850	270
Citral (—CMe:CH·CHO) (125°)	2450	200	2570	235
	2560	200	2800	180
	2800	185	2910	155
	2910	115	3850	310
	3830	300		
Unsaturated aldehyde (—CH:CMc·CHO) (149°) ⁴	2280	195	2560	215
	2550	195	2820	165
	2870	120	2920	140
	2910	105	3830	305
	3770	280		
Unsaturated aldehyde (—CH:CMc·CHO) (165°) ⁴	2440	175	2560	190
	2530	175	2810	145
	2810	135	2900	110
	2910	120	3830	295
	3810	320		
β -cycloCitral (—CMe: ¹ C·CHO) (173°)	2250	140	2570	175
	2550	155	2790	150
	2820	100	2920	115
	3870	265	3890	280
Ph·CHO	2230	245	2550	150
	2530	130	3770	285
	3770	295		
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CMe ₂ :CH·COMe (200°)	2240	165	2550	190
	2560	175	2800	140
	2800	100	2910	100
	3790	225	3890	250
α -Ionone (—CH:CH·COMe) (138°)	2230	170	2560	225
	2450	185	2800	185
	2520	185	2900	170
	2820	145	3890	250
	3770	280		
Acetyl- Δ^1 -cyclohexene (>C: ¹ C·COMe) (207°)	2280	155	2530	200
	2550	155	2810	165
	2800	130	3870	275
	3770	240		

TABLE I (contd.).
Light absorption of 2 : 4-dinitrophenylhydrazones.

Carbonyl compound.	Solvent : EtOH.		Solvent : CHCl ₃ .	
	$\lambda_{\max.}, \text{A.}$	$\epsilon_{\max.} \times 10^{-2}$	$\lambda_{\max.}, \text{A.}$	$\epsilon_{\max.} \times 10^{-2}$
Δ^4 -Cholestenone ($>\text{C}:\text{CH}\cdot\text{CO}-$) (233°) ³	—	—	2560 2810 2920 3930	215 160 115 295
Δ^4 -Sitostenone ($>\text{C}:\text{CH}\cdot\text{CO}-$) (247°) ³	—	—	2590 2820 2920 3950	215 160 140 315
Stigmastadienone ($>\text{C}:\text{CH}\cdot\text{CO}-$) (245°) ³	—	—	2420 2650 2800 2930 3930	215 230 185 170 310
COPhMe (249°)	2180 2650 2800 3770	275 200 190 260	2560 2800 2900 3800	140 120 105 275
COPh·CH(OH)Ph (174°)	—	—	2580 2800 3910	210 160 300
CHMe:CM ₂ :CH:CH·CHO (194°) ⁵	—	—	2420 2600 2800 3080 3920	235 235 210 185 420
CM ₂ :CH·CH ₂ ·CH ₂ ·CM ₂ :CH·CH:CH·CHO (132°) ⁶	—	—	2650 3080 4000	460 370 460
Furfuraldehyde (223°)	2270 2560 2800 3000 3900	150 125 85 85 270	2580 2780 3020 3880	180 120 105 265
ψ -Ionone ($-\text{CM}_2:\text{CH}\cdot\text{CH}:\text{CH}\cdot\text{COMe}$) (140°)	2280 2600 2810 3070 3950	170 150 135 185 320	2570 2790 3090 4070	220 200 220 345
β -Ionone ($-\text{CM}_2:\overset{ }{\text{C}}:\text{CH}:\text{CH}\cdot\text{COMe}$) (126°)	2290 2500 2800 3850	155 165 120 265	2560 2820 2920 3880	205 165 145 275
Ketone ($-\text{CH}:\overset{ }{\text{C}}:\overset{ }{\text{C}}:\text{CH}\cdot\text{CO}-$) (228°) ⁷	—	—	2580 2800 3070 4000	250 200 150 335
CM ₂ :CH·CO·CH:CM ₂ (108°)	2260 2580 2800 3880	200 160 110 245	2560 2810 3950	135 70 245
COPh ₂ (238°)	2430 3790	180 265	2420 3910	205 290
CHMe:CH·CH:CH·CH:CH·CHO (203°)	2280 2560 2800 3130 4090	210 210 180 235 480	2580 2800 3250 4100	190 145 190 365
 -CH:CM ₂ ·COEt (188°) ⁷	2300 2450 2510 3100 3160 3960	200 200 200 220 210 435	2570 2800 3080 4000	265 240 265 425

References to origin : ¹ Owen, J., 1945, in the press. ² Jones and Koch, J., 1942, 393. ³ Jones, Wilkinson, and Kerlogue, J., 1942, 391. Heilbron, Johnson, Jones, and Spinks, J., 1942, 727. ⁶ Heilbron, Jones, and Koch, J., 1942, 735. ⁶ Kuhn, Badstübner, and Grundmann, *Ber.*, 1936, **69**, 105. ⁷ Heilbron, Johnson, and Jones, J., 1939, 1560.

TABLE II.

Principal bands of 2 : 4-dinitrophenylhydrazones and corresponding carbonyl compounds.

System.	$\lambda_{\max.}$ (EtOH), Å.	$\lambda_{\max.}$ (CHCl ₃), Å.	$\epsilon_{\max.}$ $\times 10^{-2}$.	System.	$\lambda_{\max.}$ (EtOH), Å.	$\epsilon_{\max.}$ $\times 10^{-2}$.	$\Delta\lambda$ *	$\Delta\epsilon$.
NHX·NH ₂	3500	3430	150	O·CH ₂	No high intensity absorption > $\lambda = 2000$ Å.			
NHX·N·CH ₃	3480	3480		O·CHR ₁				
NHX·N·CHR ₁	3560—3600	3580—3610	200—300	O·CR ₁ R ₂				
NHX·N·CR ₁ R ₂	3620—3650	3650—3680		O·CH·CH·CH ₂	2080 ¹	1590		
NHX·N·CH·CH·CH ₂	3660	3670		O·CH·CH·CHR ₁	2170 ¹	1600		
NHX·N·CH·CH·CHR ₁	3730	3730		O·CR ₁ ·CH·CHR ₂	2240 ¹	1500		
NHX·N·CR ₁ ·CH·CHR ₂	3760	3800		O·CH·CR ₁ ·CHR ₂	2280 ¹	1520		
NHX·N·CH·CH·CR ₁ R ₂	3770—3830	3820—3850	250—350	O·CH·CH·CR ₁ R ₂	2350 ¹	1450		
NHX·N·CR ₁ ·CH·CR ₂ R ₃	3770—3790	3870—3950		O·CR ₁ ·CH·CR ₂ R ₃	2390 ¹	1390		
NHX·N·CH·CR ₁ ·CR ₂ R ₃	3870	3890		O·CH·CR ₁ ·CR ₂ R ₃	2450 ¹	1420		
NHX·N·CH·CH·CH·CH·CHR ₁	3790—3950	3880—4070	300—400	O·CH·CH·CH·CH·CHR ₁	2650 ^{1,2}	250	1210	~100
NHX·N·CR ₁ ·CH·CH·CH·CHR ₂				O·C<CH·CHR ₁ CH·CHR ₂				
NHX·N·C<CH·CHR ₁ CH·CHR ₂	3950—4100	4000—4150	400—500	O·CH·CH·CH·CH·CH·CH·CHR ₁	3140 ³	350	1110	~100
NHX·N·CH·CH·CH·CH·CH·CH·CHR ₁								
NHX·N·CR ₁ ·CH·CH·CH·CH·CH·CHR ₂								

¹ Evans and Gillam, J., 1941, 815; 1943, 565.² Scheibe, *Ber.*, 1925, 58, 587.³ Smakula, *Angew. Chem.*, 1935, 48, 152.* Difference between $\lambda_{\max.}$ (EtOH) for 2 : 4-dinitrophenylhydrazone and corresponding carbonyl compound.

It is evident that $\lambda_{\max.}$ varies not only with the number (n) of ethylenic bonds in the system $\text{NHX} \cdot \text{N} \cdot \text{C} \cdot [\text{C} \cdot \text{C}]_n$, where X stands for the 2 : 4-dinitrophenyl group, but also with the degree of alkyl substitution in the $\text{NHX} \cdot \text{N} \cdot \text{C}-$ and $\text{NHX} \cdot \text{N} \cdot \text{C} \cdot \text{C}-$ systems. The bathochromic effects of a conjugated ethylenic bond and an alkyl substituent are of the order of $+\Delta\lambda = 100-150\text{Å}$. and $50-100\text{Å}$., respectively. The former value is considerably smaller than that of $+\Delta\lambda = \text{ca. } 250\text{Å}$. found for the bathochromic effect in the 3000—4000 Å. region of a conjugated ethylenic bond in conjugated systems such as $\text{Y} \cdot [\text{C} \cdot \text{C}]_n$, where Y is $-\text{C} \cdot \text{C}-$, $-\text{C} \cdot \text{O}-$, or phenyl. The latter value corresponds to that found for the bathochromic effect of alkyl substituents in the $-\text{C} \cdot \text{C} \cdot \text{C} \cdot \text{C}-$, $-\text{C} \cdot \text{C} \cdot \text{C} \cdot \text{O}$, and $-\text{C} \cdot \text{C} \cdot \text{C} \cdot \text{C}-$ systems (Hausser, Kuhn, *et al.*, *Z. physikal. Chem.*, 1935, 329, 363 *et seq.*; Booker, Evans, and Gillam, J., 1940, 1453; Evans and Gillam, J., 1941, 815; Woodward, *J. Amer. Chem. Soc.*, 1941, 63, 1123; 1942, 64, 72, 76; Braude and Jones, forthcoming paper). Alkyl substituents have little effect on the intensity, but the $\lambda_{\max.}$ of the principal band increases with the number of ethylenic double bonds, as it does in other conjugated systems. A comparison of the light-absorption properties of dinitrophenylhydrazones and the corresponding unsaturated carbonyl compounds is included in Table II.

The subsidiary bands, being more in the nature of inflexions than distinct maxima, are much less well defined than the principal bands, and show only slight correlation with the nature of the parent carbonyl compounds. Bands at *ca.* 2200 and 2600 Å. are shown by 2 : 4-dinitrophenylhydrazine itself (Table III) and all the dinitrophenylhydrazones; in addition a band at *ca.* 2800 Å. is exhibited by most dinitrophenylhydrazones, and further bands appear at *ca.* 2900 and 3100 Å. when $n = 2$.

The effect of change of solvent on the location of the principal maximum [$\Delta\lambda = \lambda_{\max.}(\text{CHCl}_3) - \lambda_{\max.}(\text{EtOH})$] increases from $+\Delta\lambda = \text{ca. } 10$ to *ca.* 100 Å. with n in the system $\text{NHX} \cdot \text{N} \cdot \text{C} \cdot [\text{C} \cdot \text{C}]_n$, whereas ϵ shows only slight, apparently random variations. Dinitrophenylhydrazine itself, on the other hand, shows a solvent effect opposite in sign ($\Delta\lambda = -70$ Å.) (Table III).

TABLE III.

Light absorption of 2 : 4-dinitrophenylhydrazine.

Solvent : EtOH.	Solvent : CHCl ₃ .
$\lambda_{\max.}$, Å.	$\lambda_{\max.}$, Å.
$\epsilon_{\max.} \times 10^{-2}$.	$\epsilon_{\max.} \times 10^{-2}$.
2190	—
2580	2605
3500	3435
4150	4000
120	100
95	145
145	50
60	

Light absorption of 2 : 4-dinitroaniline.

Solvent : EtOH.	Solvent : CHCl ₃ .
$\lambda_{\max.}$, Å.	$\lambda_{\max.}$, Å.
$\epsilon_{\max.} \times 10^{-2}$.	$\epsilon_{\max.} \times 10^{-2}$.
2230	—
2560	2590
3350	3330
~3850	~3800
115	110
100	145
145	65
70	

DISCUSSION.

The 2 : 4-dinitrophenylhydrazones were examined in preference to simpler derivatives such as the phenylhydrazones or the *p*-nitrophenylhydrazones because of the practical considerations referred to above, although in comparison with the latter derivatives the theoretical treatment of the light absorption of the more complicated systems presents greater difficulties.

In Part I (preceding paper) the term "partial" chromophore was used in order to facilitate the discussion of complex light-absorbing systems. Without attempting an analysis of the light absorption due to the partial chromophore represented by 2 : 4-dinitroaniline (NH_2X), the data given in Table III show that replacement of a hydrogen atom by a second amino-group to give 2 : 4-dinitrophenylhydrazine ($\text{NHX} \cdot \text{NH}_2$) results in a bathochromic displacement of the long wave-length band by *ca.* 150 Å., while the 2600 Å. band remains almost unaffected (*cf.* Macbeth and Price, J., 1935, 1563). Bathochromic effects of the same magnitude are observed in phenylhydrazine as compared with aniline, and in aniline as compared with benzene (*cf.* Biquard, *Bull. Soc. chim.*, 1936, 3, 909), whereas the bathochromic effect of an amino-group when directly attached to

certain substituted benzenoid or to ethylenic systems is known to be considerably greater, being of the order of $+\Delta\lambda = 300\text{--}600\text{ \AA}$. (cf. Ramart-Lucas and Wohl, *Compt. rend.*, 1933, 196, 804; Part I; and unpublished results obtained in these laboratories). Hydrazine in aqueous solution exhibits no absorption of appreciable intensity ($\epsilon > 1$) in the 2100—6000 \AA . region, and the variochromic properties of the amino-group in the ultra-violet thus fit in well with the classical concept of an auxochrome. The latter, in contradistinction to a chromophore (e.g., an ethylenic double bond), is a group which does not produce a system exhibiting high-intensity absorption in a given region of the spectrum when conjugated with itself, but does produce such a system when conjugated with a chromophore.

In the 2 : 4-dinitrophenylhydrazones of non-conjugated carbonyl compounds the primary amino-group of the hydrazine is replaced by the >N:C< group without appreciable alteration in the light absorption. The conjugating power of the >N:C< group when attached to a conjugated system through the >NH group is thus of the same order as that of the amino-group and, again, it is considerably smaller than when directly joined to an ethylenic system (Evans and Gillam, J., 1943, 565; unpublished work). The >NH group thus has a smaller transmitting ("chromolatory") capacity for conjugation than, for instance, an ethylenic bond, and this may well be a general characteristic of auxochromes.

In the derivatives of $\alpha\beta$ -unsaturated carbonyl compounds, the chromophoric system is extended (to $\text{NHX}\cdot\text{N:C:C:C-}$) and λ_{max} increases, but because of the smaller chromolatory capacity of the >NH group, the bathochromic effect of the ethylenic bond is smaller than that usually observed in conjugated systems of the type $\text{Y}\cdot[\text{C:C}]_n$. Further, when the number (n) of double bonds in $\text{NHX}\cdot\text{N:C}\cdot[\text{C:C}]_n$ is increased, the relation $(\lambda_{\text{max}})^2 = an$, valid in other polyene systems, is obeyed but the constant a has a smaller value than in the case of the system $\text{O:C}\cdot[\text{C:C}]_n$ (Fig. 1a). The bathochromic effect of alkyl substituents ($+\Delta\lambda_{\text{alk.}} = 50\text{ \AA}$.) is almost fully exerted, however ($\Delta\lambda$ in Table II decreases but slightly with increasing alkyl substitution), and this is particularly interesting in view of the non-operation of this effect in the closely allied semicarbazones (Evans and Gillam, *loc. cit.*). Thus, light absorption data for dinitrophenylhydrazones are more valuable for obtaining structural evidence than similar data derived from the semicarbazones. The system $\text{-CO}\cdot\text{NH}\cdot\text{N:C:C:C-}$, contained in the latter derivatives of $\alpha\beta$ -unsaturated carbonyl compounds, provides a further illustration of the variochromic properties of the >NH group. The high-intensity absorption ($\lambda_{\text{max.}}$ ca. 2650 \AA .) cannot be ascribed to enolisation to -C(OH):N:N:C:C- , since the same absorption is shown by the corresponding *N*-methylsemicarbazones in which such enolisation cannot occur (Evans and Gillam, *loc. cit.*). It seems clear that the displacement of the maximal absorption, as compared with the >N:C:C:C- system present in the $\alpha\beta$ -unsaturated oximes, which have $\lambda_{\text{max.}}$ ca. 2300 \AA ., is due to the bathochromic effect of the >NH group and the partially transmitted conjugation with the carbonyl group.

The phenyl groups in 2 : 4-dinitrophenylhydrazones of the type $\text{NHX}\cdot\text{N:CPh}$ produce a bathochromic effect of the same magnitude ($+\Delta\lambda_{\text{Ph}}$ ca. 200 \AA .) as that of an ethylenic bond, in contrast to other conjugated systems such as the diphenylpolyenes, where $\Delta\lambda_{\text{Ph}} \sim 1.5\Delta\lambda_{\text{C=C}}$ (Hausser, Kuhn, *et al.*, *loc. cit.*). Similarly, the bathochromic effect of an acetylenic bond conjugated with the $\text{NHX}\cdot\text{N:C-}$ system is smaller than that of an ethylenic bond, whereas in other conjugated systems $\Delta\lambda_{\text{C}\equiv\text{C}} \sim \Delta\lambda_{\text{C=C}}$ (Heilbron, Jones, and Raphael, J., 1944, 186 and unpublished work). Again, α -carboxyl groups produce practically no bathochromic shift, whereas in systems of the type $\text{-(C:C)}_n\cdot\text{CO}_2\text{H}$, $+\Delta\lambda_{\text{CO}_2\text{H}} \sim 200\text{ \AA}$.

Bisdinitrophenylhydrazones show normal absorption except in the case of α -diketones, where conjugation occurs between the two hydrazone systems and $\lambda_{\text{max.}}$ increases considerably.

The technique of the light-absorption measurements has been described in Part I (preceding paper).

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