that moonlight is 44 times brighter than starlight when unabsorbed by more than 1 atmosphere, and if uniformly distributed, though, for illumination of a horizontal screen, it is 175 times brighter so far as photographic action is concerned. If we take the visual quality of the two lights to be the same, these figures should bear the same proportion for visual observation. If moonlight be 0·01 candle at 1 foot distance, starlight will be 0·000057 candle at the same distance, that is, the visual value of one candle at nearly 132 feet distant from a screen. With an intensity of about 6/1000000 of candle placed at 1 foot from a screen, or about 10 times less illumination than the above, the screen would be invisible. It follows that the actual illumination given by starlight will be less than that stated.

Addendum. March 25, 1896.

I ought to have drawn attention to the fact that though the above comparison of moonlight with starlight was taken from actual observations, it would not have been unfair to have deduced the value of moonlight as observed at Wimbledon with the moon in the zenith. From the observations made and recorded in my paper on the "Transmission of Sunlight through the Earth's Atmosphere," the coefficient of absorption μ for the rays affecting the bromo-iodide of silver can be shown to be 0·340, under the very favourable circumstances under which the exposures were given. As the rays of the moon had to traverse 1·45 atmosphere, and then showed a photographic illuminating power of 0·266 S.C.; had they only had to traverse a thickness of 1 atmosphere, this number would have been 0·308 S.C. This last value would have been equivalent to a visual estimation of moonlight of closely 0·012 S.C. at 1 foot. Starlight would have then been rather more than 200 times less bright than the light of the full moon.

II. "Helium, a Gaseous Constituent of certain Minerals. Part II—Density." By WILLIAM RAMSAY, F.R.S., Professor of Chemistry in University College, London. Received March 12, 1896.

§ 1. In the original notice of this gas ('Proc. Roy. Soc.,' vol. 58, p. 81), it was stated that the gas obtained from clèveite contained some, but not much, nitrogen, and no hydrogen. I have since prepared samples from bröggerite, samarskite, and fergusonite, and I find that in all cases the gas evolved on heating the mineral in a vacuum is rich in hydrogen; the amount of nitrogen is in all cases

infinitesimal. This was easily ascertained from experiments made on the spectra of mixtures of gases by Dr. Collie and myself. About 0·01 per cent. of nitrogen is still visible; and the higher the pressure the more easily is the spectrum of nitrogen seen when it is mixed with helium. With these new samples of gas, the nitrogen spectrum was just visible at a pressure of 4 or 5 mm.; and that implies that only the minutest trace can have been present. It doubtless comes off the glass tubes in which the powdered minerals were heated, or it may have adhered to the surface of the powdered mineral. I think it may be safely assumed that nitrogen is not a normal constituent of these minerals. There was always a considerable amount of carbon dioxide evolved, and, as the carbon spectrum persisted even after the gas had been passed through soda-lime, probably a hydrocarbon, but this only in minute amount.

§ 2. The yield from these sources was very variable. Whereas 1 gram of clèveite yielded 7·2 c.c. of helium, 1 gram of bröggerite yielded somewhat less than 1 c.c. of helium; the yield from samarskite was still less, about 0·6 c.c. per gram; and from fergusonite 1·1 c.c. per gram, the last by heating alone; with the other minerals, the residue after heating was fused with hydrogen potassium sulphate. There can be no doubt that clèveite is far the best source of the gas, but unfortunately it is very scarce.

§ 3. Dr. Collie, to whom I owe thanks for helping to extract these gases, was so good as to analyse the gas obtained from fergusonite on heating. It contained

Hydrogen	54·7 per cent.
Carbon dioxide	13·9 ,,
Helium................	31·2 ,,
	99·8 ,,

No hydrocarbons were present, for, after explosion with oxygen, no contraction occurred on admitting potash; the residue gave a spectrum free from nitrogen flutings even when the pressure was comparatively high.

The carbon dioxide was absorbed by soda-lime, and the remaining mixture was then circulated over the usual purifiers—red-hot copper oxide, soda-lime, phosphoric anhydride, and red-hot magnesium. Although no nitrogen was present, magnesium was introduced as a precautionary measure.

§ 4. The density of the gas extracted from bröggerite was first determined. The precautions taken and the methods of weighing were similar to those described in the paper on argon, in the 'Phil. Trans.' for 1895. The bulb, of capacity 162·843 c.c., was counterpoised by one nearly equal to it in volume and weight, and the

weighings were trustworthy to one or two hundredths of a milligram. The contraction of the globe on exhausting it of air amounted to 0·0212 c.c. The weight of the empty bulb was therefore increased by 0·000026 gram. The concordance between the mean of the determinations of the density of argon, 19·941, made with this bulb, and that found by Lord Rayleigh with one of 2 litres capacity, 19·94, shows that it is possible to obtain accurate results by its use.

Bröggerite gas—

Temperature, 17·00°; pressure, 601·2 mm.

Weight of 162·843 c.c. of gas	0·02320 gram.
Weight of 1 litre gas at 0° and 760 mm. ..	0·1949 ,,
Density, compared with O = 16	2·181 ,,

§ 5. A quantity of helium extracted from samarskite by fusion with hydrogen potassium sulphate, after all gas which would come off by heating in a vacuum had been removed, was circulated as usual. It was difficult to get a sample of gas which did not show a trace of the hydrogen spectrum; many hours of circulation over red-hot copper oxide, however, finally removed all hydrogen. It was weighed, with the following results:—

Samarskite gas, from mineral exhausted by heating with $HKSO_4$:—

Temperature, 18·60°; pressure, 771·4 mm.

Weight of 162·843 c.c. of gas	0·02860 gram.
Weight of 1 litre gas at 0° and 760° mm...	0·1896 ,,
Density, compared with O = 16	2·122 ,,

§ 6. The density of helium extracted from samarskite by heating *in vacuo* was determined. Here no nitrogen was visible in the spectrum, but, as before, the removal of all hydrogen was a long operation. Indeed this sample showed the red line of hydrogen distinctly. This, however, does not imply that it contains more than a trace, for one volume of hydrogen in 100,000 volumes of helium is still visible in the spectrum.

Samarskite gas, obtained by heating the mineral.

Temperature, 16·90°; pressure, 781·8 mm.

Weight of 162·843 c.c. of gas	0·02989 gram.
Weight of 1 litre gas at 0° and 760 m.m. ..	0·1895 ,,
Density, compared with O = 16	2·121 ,,

To remove hydrogen, 10 c.c. of oxygen were mixed with this gas, and circulation over red-hot copper oxide, soda-lime, and phosphoric anhydride was continued for a day. The next day the circulation was continued, a tube containing red-hot metallic copper being included in the circuit, so as to remove the excess of oxygen. The

spectrum of this gas still showed a trace of hydrogen, and, what was worse, some signs of nitrogen. Its density was, however, determined.

Temperature, 14·28°; pressure, 777·4 mm.	
Weight of 162·843 c.c. of gas	0·02994 gram.
Weight of 1 litre at 0° and 760 mm.	0·1892 ,,
Density, compared with O = 16	2·117 ,,

Further circulation for a day over magnesium removed this nitrogen, and hydrogen also disappeared, so that it was not visible spectroscopically. A final determination of density was made.

Temperature, 14·95°; pressure, 770·7 mm.	
Weight of 162·843 c.c. of gas	0·02957 gram.
Weight of 1 litre at 0° and 760 mm.	0·1889 ,,
Density compared with O = 16	2·114 ,,

These results will be discussed later.

§ 7. Gas was prepared from 500 grams of fergusonite. This time no drying tubes or tubes filled with soda-lime were interposed between the tube containing the mineral and the pump. There was a vacuum tube, as usual, on the way to the pump, into which samples of the gas could be introduced and examined at any desired pressure. The object of this was to make sure that no unknown gas was being rejected owing to its absorption by soda or anhydride. The result proved the precaution to have been quite unnecessary. Every line visible was identified as belonging to hydrogen, carbon, carbon dioxide, the oxygen of water vapour, or helium. It may be taken as certain that no gas capable of absorption is evolved from this mineral, and it is exceedingly improbable that any gas has been overlooked which finds its source in other minerals.

The gas from fergusonite was treated with caustic soda to remove carbon dioxide, and circulated over the usual absorbent till the hydrogen spectrum disappeared, and its density was determined.

Fergusonite gas.	
Temperature, 14·05°; pressure, 755·8 mm.	
Weight of 162·843 c.c. of gas	0·02955 gram.
Weight of 1 litre gas at 0° and 760 mm....	0·1919 ,,
Density compared with O = 16	2·147 ,,

A second determination was made with another sample which had been separately purified. The weighing globe was in the meantime cleaned and dried, and its stopcock re-greased. There had been reason to suspect a slight leakage.

Temperature, 14·28; pressure, 760·0 mm.	
Weight of 162·843 c.c. of gas	0·02957 gram.
Weight of 1 litre at 0° and 760 mm.......	0·1911 ,,
Density compared with O = 16	2·139 ,,

A third weighing was carried out with a third separately collected and purified sample. The spectrum showed the absence of nitrogen and hydrogen.

Temperature, 11·51°; pressure, 771·5 mm.	
Weight of 162·843 c.c. of gas	0·03024 gram.
Weight of 1 litre at 0° and 760 mm.......	0·1906 ,,
Density compared with O = 16..........	2·134 ,,

Previous determinations of density have been recorded ('Chem. Soc. Trans.,' 1895, p. 695). Some of these were made with a smaller bulb, and the same degree of accuracy therefore cannot be claimed for them. Still, they are included in the following table, so that the record may be complete.

Densities.

Bulb of 33·023 c.c. capacity.	Density, O = 16,
Bröggerite; heat alone	2·152
Bröggerite; fusion with $HKSO_4$.	2·187
Clèveite; fusion with $HKSO_4$....	2·205

The possible error in weighing might amount to one part in 60 or 70, which makes an uncertainty of 0·031 or 0·032 in the above figures.

Bulb of 162·843 c.c. capacity.		Means.
Mixture of gas from bröggerite and clèveite..	2·218	
Same mixture, re-circulated	2·133	
The last sample is probably the purer.		
Bröggerite gas; fresh sample	2·181	2·181
Samarskite; heat alone	2·121	2·118
Samarskite; fusion with $HKSO_4$...........	2·122	
Samarskite; gas again circulated	2·117	
Samarskite; after further circulation........	2·114	
Fergusonite; heat alone	2·147	2·140
Fergusonite; another sample	2·139	
Fergusonite; another sample	2·134	

Assuming a possible error of 0·2 milligram in weighing the globe (and this error is certainly too high), the error might amount to 0·014.

It appears to me that these numbers furnish some ground for the

supposition that, as suggested by Lockyer and by Runge and Paschen, the helium from various sources is not quite homogeneous, but that different samples differ slightly in density. I think that these numbers point to a possible division into groups. The gas from bröggerite appears to have the density 2·18, that from samarskite 2·12, and that from fergusonite 2·14. But the evidence is slender. It is not impossible that the gas from clèveite is lighter; it is unfortunate that the sample of clèveite gas was lost; but its mixture with that from bröggerite weighs less than the gas from bröggerite alone.

It has not, I think, been noticed that the light emitted from a vacuum-tube containing clèveite gas has a richer orange-yellow shade than is shown by gas from bröggerite, samarskite, and fergusonite. This is doubtless due to a greater intensity of the red line; but there is another difference. The clèveite gas shows, in addition to the usual strong lines, a set of fairly strong lines between the very strong green, and the strong blue. These lines have never been observed in samples of gas from bröggerite, samarskite, or fergusonite, no matter how high or low the pressure in the tube, or the intensity of the discharge. But the difference of colour is so marked that it is easy, at a glance, to say whether any tube contains clèveite-helium, or helium from another mineral.

Taking the two lines of evidence together, they undoubtedly strengthen each other, and I am at present engaged in an attempt to fractionate the mixed gases from bröggerite, samarskite, and fergusonite into two or more portions.

Mention should perhaps be made, in conclusion, of Langlet's determination of the density of clèveite-helium ('Zeit. anorg. Chem.,' **10**, 287). The number he obtained, weighing in a globe of 100 c.c. capacity, was 2·00. His sample was examined spectroscopically, and appears to have been free from nitrogen and hydrogen. It is unlikely that he can have made an error of 1·3 milligrams in weighing, especially as he determined the density three separate times. It is not impossible, therefore, that he had under his hands gas much richer in some light constituent than it has been my fortune to fall in with. Whether this is the case or not, further research must show.

III. "On the Reflection of Röntgen Light from Polished Speculum-Metal Mirrors." By Lord BLYTHSWOOD. Communicated by Lord KELVIN, F.R.S. Received March 13, 1896.

It has been generally supposed that the X rays cannot be reflected.