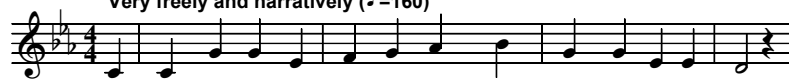


# The Solution

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Very freely and narratively ( $\text{♩} = 160$ )



The rich, red co-lour one ob-serves when view - ing ne-on signs



Is ac-tual - ly com - posed of i - so - la - ted spec - tral lines,



And this was once a mys - te-ry. When New - ton thought to pass



A beam of sun-light in a dar-kened room through be-veled glass,



He saw the rain-bow's co-lours, a con - tin-u-ous ar - ray.



But light e-mit-ted from pure gas, un - known in New-ton's day,



When spread out by a pris - m or a gra-ting, it was seen,



Forms se-pa-ra-ted, co-loured lines, with no-thing in be - tween.



E - ven - tu-al-ly it was found that each such spec-trum bears



A like-ness of the gaps be-tween re - cip-ro-cals of squares



Of in-te-gers: one fourth, one ninth. A chi-ld, still in school,



Could work out all the de-ci-mals but why was that the rule?



What is the phy-sics No-bel prize? Of what does it con - sist?



It is, of course, an hon-our, for one's name goes on a list



Of all great mo-dern phy - si - cists. The prize will al - so bring



An in - vi - ta - tion to a ban - quet with the Swe - dish king.

## The Solution

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The rich, red colour one observes when viewing neon signs  
Is actually composed of isolated spectral lines,  
And this was once a mystery. When Newton thought to pass  
A beam of sunlight in a darkened room through beveled glass,  
He saw the rainbow's colours, a continuous array.  
But light emitted from pure gas, unknown in Newton's day,  
When spread out by a prism or a grating, it was seen,  
Forms separated, coloured lines, with nothing in between.  
Eventually it was found that each such spectrum bears  
A likeness of the gaps between reciprocals of squares  
Of integers: one fourth, one ninth. A child, still in school,  
Could work out all the decimals – but why was that the rule?

In Germany, around the time this question first arose,  
The physicist Max Planck became the first one to propose  
That radiated energy, as either light or heat,  
Exists as quantized packets that are separate, discrete.  
This theory gave a good account of how hot objects glow  
And forms the basis of the quantum physics that we know.  
He later would receive the Nobel Prize and had such fame  
The Kaiser Wilhelm institute instead took on his name.  
Then Albert Einstein showed the way such quanta could explain  
Why, when light strikes a metal plate, electrons might remain  
Unmoved by bright red light when even dim blue sets them free.  
He won his Nobel Prize for this, not relativity.

What is the physics Nobel Prize? Of what does it consist?  
It is, of course, an honour, for one's name goes on a list  
Of all great modern physicists. The prize will also bring  
An invitation to a banquet with the Swedish king.

To isolated spectral lines our tale returns again.  
The quantum way of thought appealed to Niels Bohr, a Dane.  
Within the atom, he maintained, electrons are not free  
To move in orbits having arbitrary energy:  
Discretely quantized are the orbits they can occupy.  
When energy's emitted or absorbed, it's only by  
Transition jumps between these orbits, of which there are few.  
Between one pair, the energy might correspond to blue,  
Between another, yellow, and the spectrum thus could spread  
Up to the ultraviolet, or down to infrared.  
For hydrogen, Bohr's formula, within a few percent,  
Explained the squared reciprocals found through experiment.

In Copenhagen, in the years between the two world wars,  
The best of Europe's physicists were guests of Niels Bohr's.  
For some, the stays were brief; they came from Gottingen or Rome  
Or Manchester for conferences, and afterwards went home.  
The funds for this were plentiful, for profits being accrued  
Through sales of the lager that continued to be brewed  
By Carlsberg were donated to support the institute.  
Some others stayed to study there, experiment, compute,  
Discuss, refine, and publish. Many articles were read  
That came from Copenhagen, where the laboratory's head  
Continued to collaborate, encourage, and advise,  
For decades after he himself had earned the Nobel Prize.

And, more than a diploma drawn with calligraphic pen,  
A Nobel Prize's value can convert to pounds or yen.  
Enrico Fermi, with his prize, became an émigré,  
Departed fascist Italy, moved to the USA.

If X-rays, though more penetrating, are akin to light,  
Then they must have a wavelength, and in consequence they might  
Be subject to diffraction by a crystalline array,  
Its structure being revealed in the consequent display.  
This is the case, for which all crystallographers give thanks,  
So Max von Laue was added to the Nobel laureates' ranks.  
Electrons barely fast enough to cause emitted light  
When bumping into atoms would, if Niels Bohr were right,  
Have energy equivalent to that emission line  
Produced by the collision, and such light would be a sign  
Of energy absorption. For this work supporting Bohr,  
James Franck would share the Nobel Prize when he was 44.

The Prize is also tangible, an object one can hold,  
A medal, struck in Sweden, that is cast in gleaming gold:  
Nobel, the goddess Isis, and a small plate to record  
The full name of the physicist receiving the award.

Though both James Franck and Max von Laue remained in Germany  
When Nazi persecution had forced other men to flee,  
They'd smuggled their gold medals out for safety at a time  
When taking gold from Germany had been declared a crime.  
The medals were in Copenhagen; each one bore a name,  
A danger to its owner when the occupation came,  
For if it were discovered, word would certainly be sent  
To Germany, which Niels Bohr intended to prevent.  
He knew that they would not corrode if buried in the ground,  
But that would be too dangerous: the medals might be found.  
So he devised a better plan with Georg de Hevesy,  
Who never won the physics prize – his came in chemistry.

An atom, not a molecule, gold cannot be destroyed  
By ordinary means, and for that reason is employed  
In surfaces and circuits where it's vital to resist  
Corrosion and reaction, but there is a tiny list  
Of liquids in which gold dissolves. The one I'll bring to mind  
Is *aqua reg'*, in which strong nitric acid is combined  
With hydrochloric acid, and this frothing, yellow brew  
Was used by Georg de Hevesy in Copenhagen to  
Disguise two Nobel medals, each one as a separate jar,  
Unlabelled, of black liquid. When the horrors of the war  
Had ended, and the danger to the scientists had passed,  
The gold was sent to Sweden, where new medals would be cast.

### References

The essentials of both the quantum physics discoveries and the Nobel medal preservation are in Rochard Rhodes' *The Making of the Atomic Bomb* (Simon & Schuster, 1986). He states, however, that "the Nobel Foundation recast [the dissolved medals] and returned them to their owners", although the Foundation's own web site, at <http://www.nobel.se/nobel/medals>, states "The Nobel medals had been kept in the chemical substance in such a way that the Royal Mint in Stockholm preferred to strike new medals instead of trying to get them out of their wrapping." George [de] Hevesy's collected papers, *Adventures in Radioisotope Research* (Pergamon Press, 1962), state only "the gold was recovered and the Nobel Foundation generously presented Laue and Franck with new Nobel medals", a statement consistent with either interpretation. The web page at <http://www.nobel.se/nobel/medals/physics-chemistry.html> describes and illustrates the images on the medals. The basic facts about quantum physics and the nature of the work for which the Nobel prizes were awarded are found in numerous sources.