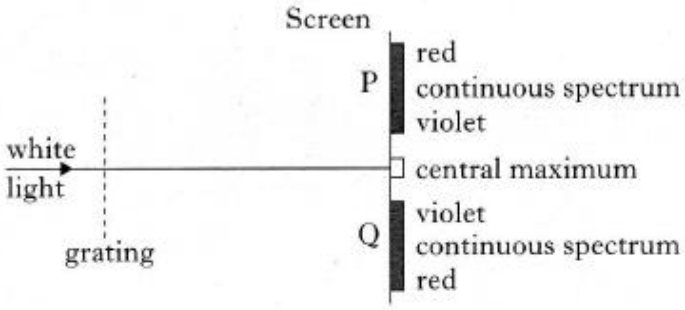
Exercise 16 – Spectra

Past Paper Homework Questions

1. When white light passes through a grating, maxima of intensity are produced on a screen, as shown below. The central maximum is white. Continuous spectra are obtained at positions P and Q.



In the continuous spectra, violet is observed closest to the central maximum.

Which of the following statements is/are true?

I Violet light has the shortest wavelength of all the visible radiations.

II Violet light has the longest wavelength of all the visible radiations.

III Violet light travels faster through air than the other visible radiations.

A I only

B II only

C III only

D I and III only

E II and III only

2. The spectrum of white light from a filament lamp may be viewed using a prism or a grating.

A student, asked to compare the spectra formed by the two methods, made the following statements.

I The prism produces a spectrum by refraction. The grating produces a spectrum by interference.

II The spectrum formed by the prism shows all the wavelengths present in the white light. The spectrum formed by the grating shows only a few specific wavelengths.

III The prism produces a single spectrum. The grating produces more than one spectrum.

Which of the above statements is/are true?

A I only

B II only

C I and II only

D I and III only

E I, II and III

3. The intensity of light from a point source is $20\,W\,m^{-2}$ at a distance of 5·0 m from the source.

What is the intensity of the light at a distance of 25 m from the source?

A $0{\cdot}032\,W\,m^{-2}$

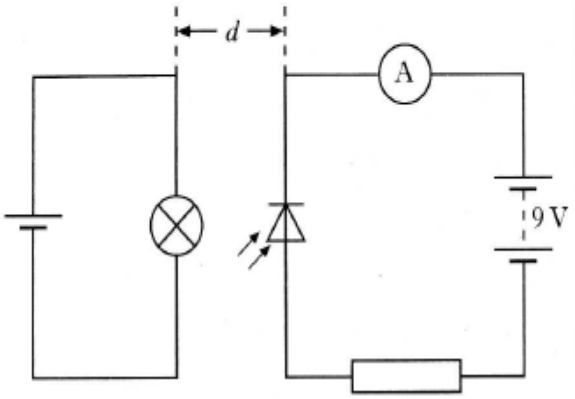
B $0{\cdot}80\,W\,m^{-2}$

C $1{\cdot}2\,W\,m^{-2}$

D $4{\cdot}0\,W\,m^{-2}$

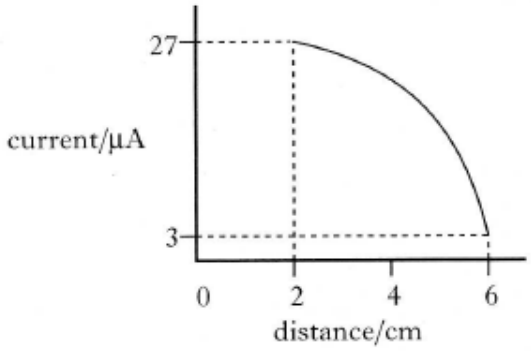
E $100\,W\,m^{-2}$

4. In a darkened room, a small lamp is placed 2 cm from a photodiode which is connected in the circuit as shown. The lamp may be regarded as a point source. The reading on the ammeter is 27 μA.

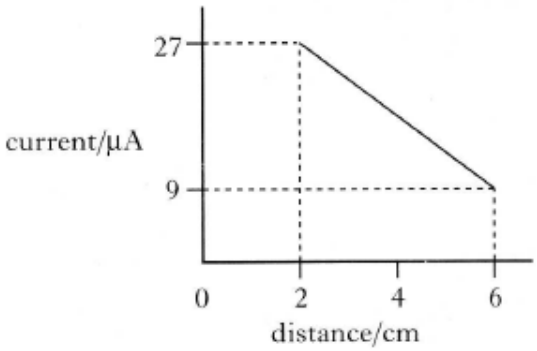


Which graph shows correctly how the ammeter reading changes as the distance d between the lamp and the photodiode is increased to 6 cm?

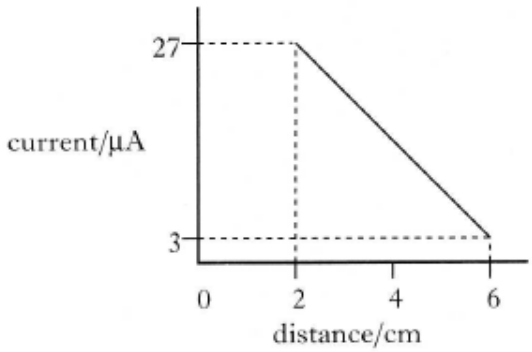
A



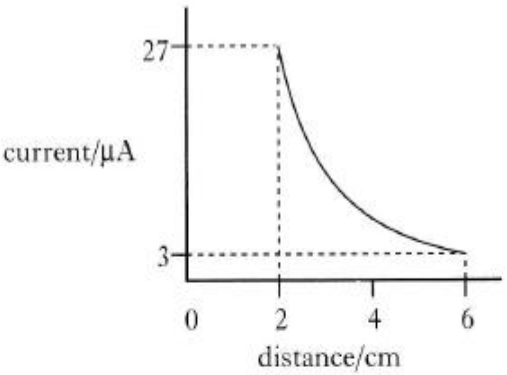
B



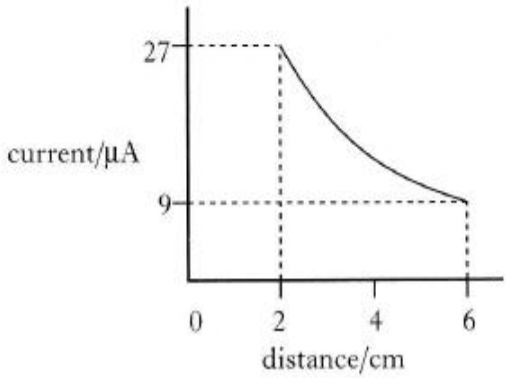
C



D



E



5. A unit for the intensity of light is

A $\mathrm{J\,m^{-1}}$

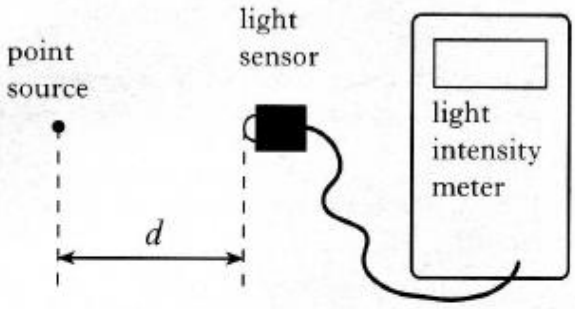
B $\mathrm{J\,m^{-2}}$

C $\mathrm{J\,s^{-1}\,m^{-1}}$

D $\mathrm{J\,s^{-1}\,m^{-2}}$

E $\mathrm{J\,s^{-2}\,m^{-2}}$.

6. The apparatus used to investigate the relationship between light intensity I and distance d from a point source is shown.



The experiment is carried out in a darkened room.

Which of the following expressions gives a constant value?

A $I \times d$

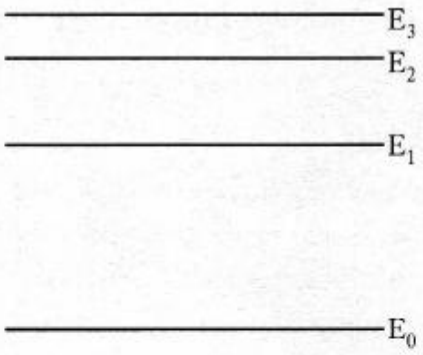
B $I \times d^2$

C $\frac{I}{d}$

D $\frac{I}{d^2}$

E $I \times \sqrt{d}$

7. An atom has the energy levels shown.



Electron transitions occur between all of these levels to produce emission lines in the spectrum of this atom.

How many emission lines are produced by transitions between these energy levels?

A 3

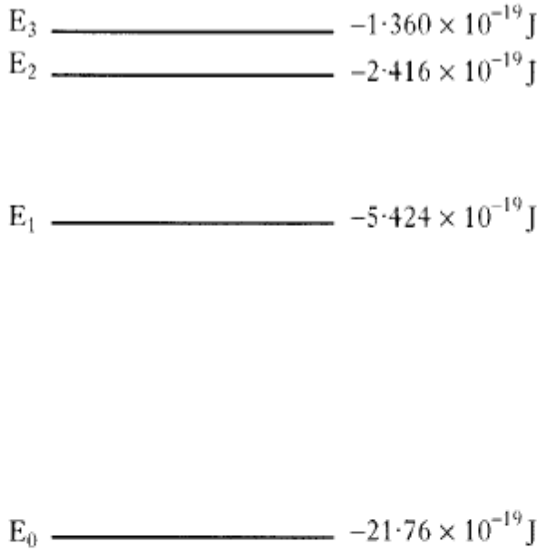
B 4

C 5

D 6

E 7

8. The diagram shows some of the energy levels for the hydrogen atom.



The highest frequency of radiation emitted due to a transition between two of these energy levels is

A $1{\cdot}59 \times 10^{14}$ Hz

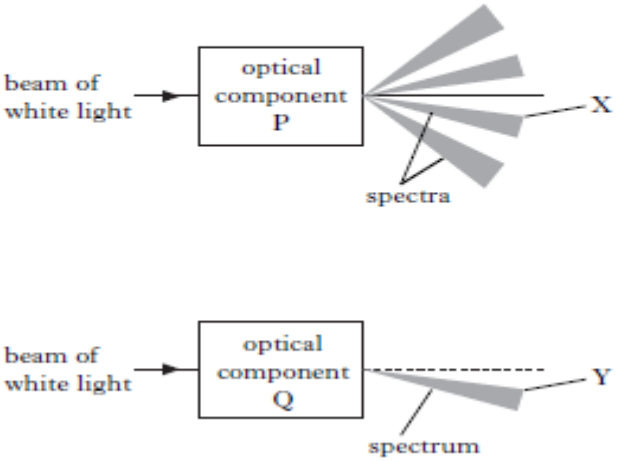
B $2{\cdot}46 \times 10^{15}$ Hz

C $3{\cdot}08 \times 10^{15}$ Hz

D $1{\cdot}63 \times 10^{20}$ Hz

E $2{\cdot}04 \times 10^{20}$ Hz.

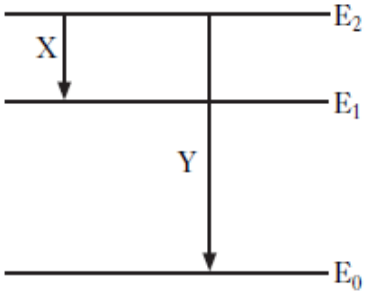
9. A beam of white light is passed through two optical components P and Q. Component P produces a number of spectra and component Q produces a spectrum as shown.



Which row in the table identifies the optical components and the colour of light seen at position X and position Y?

	Optical component P	*Colour seen at X*	*Optical component Q*	*Colour seen at Y*
A	grating	red	triangular prism	red
B	grating	red	triangular prism	violet
C	grating	violet	triangular prism	red
D	triangular prism	red	grating	violet
E	triangular prism	violet	grating	red

10. Part of the energy level diagram for an atom is shown.



X and Y represent two possible electron transitions.
Which of the following statements is/are correct?

I Transition Y produces photons of higher frequency than transition X.

II Transition X produces photons of longer wavelength than transition Y.

III When an electron is in the energy level E_0, the atom is ionised.

A I only

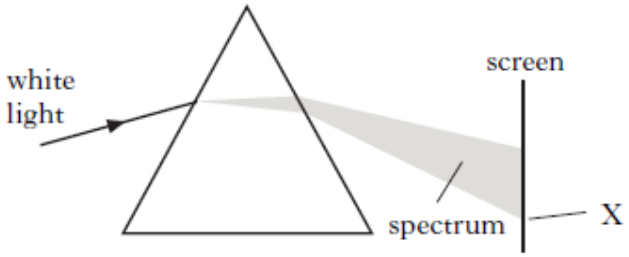
B I and II only

C I and III only

D II and III only

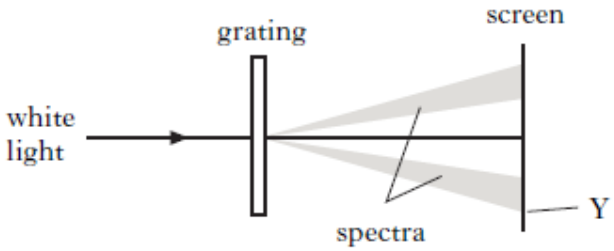
E I, II and III

11. A prism is used to produce a spectrum from a source of white light as shown.



The colour observed at X is noted.

The prism is then replaced by a grating to produce spectra as shown.



The colour observed at Y is noted.

Which row in the table gives the colour and wavelength of the light observed at X and the light observed at Y?

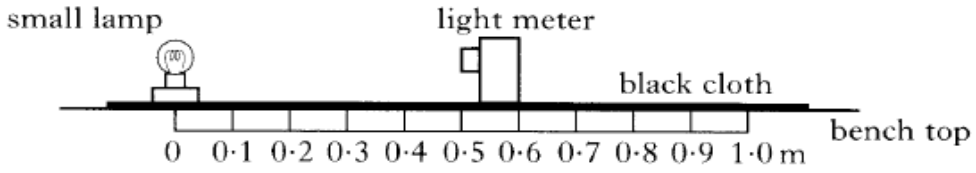
	Colour of light at X	Wavelength of light at X/nm	Colour of light at Y	Wavelength of light at Y/nm
A	Red	450	Red	450
B	Blue	450	Blue	450
C	Blue	650	Red	450
D	Blue	450	Red	650
E	Red	650	Blue	450

12. A student carries out an experiment to investigate how irradiance on a surface varies with distance from a small lamp.

Irradiance is measured with a light meter.

The distance between the small lamp and the light meter is measured with a metre stick.

The apparatus is set up as shown in a darkened laboratory.



The following results are obtained.

Distance from source/ m	0·20	0·30	0·40	0·50
Irradiance/ units	675	302	170	108

(*a*) What is meant by the term *irradiance*? **1**

(*b*) Use **all** the data to find the relationship between irradiance I and distance d from the source. **2**

(*c*) What is the purpose of the black cloth on top of the bench? **1**

(*d*) The small lamp is replaced by a laser.

Light from the laser is shone on to the light meter.

A reading is taken from the light meter when the distance between it and the laser is 0·50 m.

The distance is now increased to 1·00 m.

State how the new reading on the light meter compares with the one taken at 0·50 m.

Justify your answer. **2**

13. (*a*) Electrons which orbit the nucleus of an atom can be considered as occupying discrete energy levels.

The following diagram shows some of the energy levels for a particular atom.

E_4 ——— $-1{\cdot}4 \times 10^{-19}$ J

E_3 ——— $-2{\cdot}4 \times 10^{-19}$ J

E_2 ——— $-5{\cdot}6 \times 10^{-19}$ J

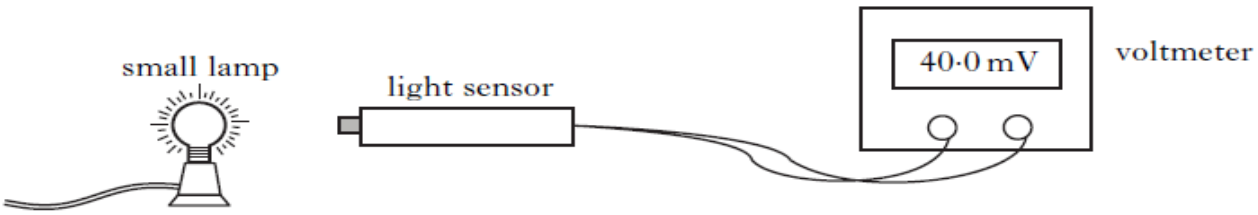
E_1 ——— $-21{\cdot}8 \times 10^{-19}$ J

(i) The transition between which two of these energy levels produces radiation with the longest wavelength? You must justify your answer.

(ii) Calculate the frequency of the photon produced when an electron falls from E_3 to E_2. **5**

14. The diagram shows a light sensor connected to a voltmeter.

A small lamp is placed in front of the sensor.



The reading on the voltmeter is 20 mV for each 1·0 mW of power incident on the sensor.

(*a*) The reading on the voltmeter is 40·0 mV.

The area of the light sensor is $8{\cdot}0 \times 10^{-5}\,m^2$.

Calculate the irradiance of light on the sensor. **3**

(*b*) The small lamp is replaced by a different source of light.

Using this new source, a student investigates how irradiance varies with distance.

The results are shown.

Distance/m	0·5	0·7	0·9
Irradiance/W m^{-2}	1·1	0·8	0·6

Can this new source be considered to be a point source of light?

Use **all** the data to justify your answer. **2**

(5)