

1.

The wavenumber of a transition is  $2000\text{ cm}^{-1}$ . In what part of the electromagnetic spectrum does this come?

- Infrared.
- Ultraviolet-visible.
- Microwave.
- Radiowave.

2.

The frequency of a transition is  $5.4 \times 10^{15}\text{ Hz}$ . What is the corresponding wavelength?

- $180\,000\text{ cm}^{-1}$
- $5.6 \times 10^{-8}\text{ m}$
- $560\text{ nm}$
- $5.6 \times 10^{-6}\text{ m}$

3.

According to the Beer-Lambert Law, on which of the following does absorbance *not* depend?

- Solution concentration.
- Extinction coefficient of the sample.
- Distance that the light has travelled through the sample.
- Colour of the solution.

4.

What is the name of an instrument used to measure the absorbance of a coloured compound in solution?

- Colourmeter.
- Colorimeter.
- Coulometer.

Calorimeter.

5.

A solution of X of concentration  $0.010 \text{ mol dm}^{-3}$  gives an absorbance of 0.5. What concentration is a solution of X which gives an absorbance reading of 0.25? Assume that the same optical cell is used for both readings.

- $0.020 \text{ mol dm}^{-3}$
- $0.0050 \text{ mol dm}^{-3}$
- $0.050 \text{ mol dm}^{-3}$
- $0.010 \text{ mol dm}^{-3}$

6.

Compound Z absorbs light of wavelength 320 nm. A  $1.0 \times 10^{-3} \text{ mol dm}^{-3}$  solution of a compound Z gives an absorbance reading of 0.15 when placed in a solution cell of path length 1 cm. What is the value of the molar extinction (absorption) coefficient of Z?

- $1500 \text{ dm}^3 \text{ mol}^{-1} \text{ cm}^{-1}$
- $150 \text{ dm}^3 \text{ mol}^{-1} \text{ cm}^{-1}$
- $15 \text{ dm}^3 \text{ mol}^{-1} \text{ cm}^{-1}$
- $1.5 \times 10^{-4} \text{ mol dm}^{-3} \text{ cm}^{-1}$

7.

The dichromate ion absorbs light of wavelength close to 500 nm. Based on this information, what can you conclude?

- The dichromate ion absorbs outside the visible region.
- The dichromate ion absorbs within the visible region.
- The dichromate ion absorbs in the ultraviolet region.
- Solutions of the dichromate ion are colourless.

8.

A solution of a dye absorbs light of wavelength 480 nm, and for this absorption, the extinction coefficient is  $18600 \text{ dm}^3 \text{ mol}^{-1} \text{ cm}^{-1}$ . A sample of the dye of unknown concentration is placed in an optical cell of path length 1 cm and the absorbance reading is 0.18. What is the concentration of the solution?

- $9.7 \times 10^{-6} \text{ mol dm}^{-3}$

- 0.026 mol dm<sup>-3</sup>
- $2.0 \times 10^{-8}$  mol dm<sup>-3</sup>
- $3.0 \times 10^{-4}$  mol dm<sup>-3</sup>

9.

The wavelength of an absorption is 495 nm. In what part of the electromagnetic spectrum does this lie?

- Radiowave.
- Microwave.
- Ultraviolet-visible.
- Infrared.

10.

The frequency of a transition is  $3.1 \times 10^{10}$  Hz. What is the energy of this transition?

- $2.0 \times 10^{-23}$  kJ
- $2.0 \times 10^{-23}$  J
- $2.1 \times 10^{-44}$  J
- $2.1 \times 10^{-44}$  kJ

11.

Which of the following statements is *correct*?

- Infrared radiation has a shorter wavelength than visible light.
- Microwave radiation possesses more energy than infrared radiation.
- Infrared radiation has a lower wavenumber than visible light.
- Ultraviolet radiation has a longer wavelength than infrared radiation.

12.

A solution of compound Z absorbs light of wavelength 256 nm, and for this absorption,  $\log \epsilon = 3.3$ . What is the concentration of a solution of Z (in an optical cell of path length 1 cm) that gives the absorbance reading is 0.21?

- $2.4 \times 10^{-3}$  mol dm<sup>-3</sup>

- 0.064 mol dm<sup>-3</sup>
- $1.1 \times 10^{-4}$  mol dm<sup>-3</sup>
- $5.0 \times 10^{-4}$  mol dm<sup>-3</sup>

13.

Which statement is *correct*?

- Wavelength is directly proportional to energy.
- Wavenumber is directly proportional to wavelength.
- Wavenumber is directly proportional to energy.
- Wavelength is directly proportional to frequency.

14.

Aqueous KMnO<sub>4</sub> solutions are purple. A plot of absorbance against concentration is:

- linear with a negative gradient.
- an exponential curve.
- linear with a positive gradient.
- non-linear.

15.

A shift to lower wavenumber for an absorption in a spectrum corresponds to:

- a shift to higher energy.
- a shift to lower wavelength.
- a loss of intensity.
- a shift to lower frequency.

16.

An absorption in an electronic spectrum is recorded at 17 000 cm<sup>-1</sup>. What does this correspond to in nm?

- 590 nm
- 5900 nm

59 000 nm

59 nm

17.

A  $0.100 \text{ mol dm}^{-3}$  aqueous solution of a nickel(II) salt shows three absorbances, one of which has a value of  $\epsilon = 2.95 \text{ dm}^3 \text{ mol}^{-1} \text{ cm}^{-1}$ . What is the corresponding absorbance, if the path length of the solution cell used for the measurement is  $1.00 \text{ cm}$ ?

0.0340

29.5

0.340

0.295

18.

A copper(II) sulfate solution of unknown concentration is placed in a colorimeter and an absorbance reading of  $0.46$  is recorded. Using the same solution cell, a  $0.055 \text{ M}$  solution of copper(II) sulfate gives an absorbance reading of  $0.34$ . What is the concentration of the first solution?

$0.35 \text{ mol dm}^{-3}$

$8.60 \times 10^{-3} \text{ mol dm}^{-3}$

$0.074 \text{ mol dm}^{-3}$

$0.041 \text{ mol dm}^{-3}$

19. An atom in an excited state of  $4.9 \text{ eV}$  emits a photon and ends up in the ground state. The lifetime of the excited state is  $1.2 \times 10^{-13} \text{ s}$ . What is the spectral line width (in wavelength) of the photon?

20. Assuming that the width of a spectral line is the result solely of lifetime broadening, estimate the lifetime of a state that gives rise to a line of width (a)  $1.0 \text{ cm}^{-1}$ , (b)  $0.50 \text{ Hz}$ .