Edexcel AS Physics: Waves and Particle Nature of Light – Calculation Practice

Praneel Physics

1. A wave has a frequency of 500 Hz and a wavelength of 0.6 m. Calculate the speed of the wave. **(P)**

Working and Answer:
Using the wave equation $v = f\lambda$, where v is the speed, f is the frequency, and λ is the wavelength.
Substituting the values: $v = 500\,\text{Hz} \times 0.6\,\text{m} = 300\,\text{m/s}$.
Answer: $300\,\text{m/s}$

2. A sound wave travels at a speed of 340 m/s. If its frequency is 170 Hz, what is its wavelength? **(P)**

Working and Answer:
Using the wave equation $\lambda = \dfrac{v}{f}$.
Substituting the values: $\lambda = \dfrac{340\,\text{m/s}}{170\,\text{Hz}} = 2\,\text{m}$.
Answer: 2 m

3. Calculate the frequency of a wave with a wavelength of 2 m that travels at a speed of 10 m/s. **(P)**

Working and Answer:
Using the wave equation $f = \frac{v}{\lambda}$.
Substituting the values: $f = \frac{10\,\text{m/s}}{2\,\text{m}} = 5\,\text{Hz}$.
Answer: 5 Hz

4. A light wave has a frequency of $6 \times 10^{14}\,\text{Hz}$. Calculate its wavelength in a vacuum. (Use $c = 3 \times 10^8\,\text{m/s}$) **(P)**

Working and Answer:
Using the wave equation $\lambda = \dfrac{c}{f}$.
Substituting the values: $\lambda = \dfrac{3 \times 10^8\,\text{m/s}}{6 \times 10^{14}\,\text{Hz}} = 5 \times 10^{-7}\,\text{m}$.
Answer: $5 \times 10^{-7}\,\text{m}$

5. A wave has a speed of 1500 m/s and a wavelength of 0.75 m. What is its frequency? **(P)**

Working and Answer:
Using the wave equation $f = \frac{v}{\lambda}$.
Substituting the values: $f = \frac{1500\,\text{m/s}}{0.75\,\text{m}} = 2000\,\text{Hz}$.
Answer: 2000 Hz

6. A sound wave has a frequency of 440 Hz and travels through air at 343 m/s. Calculate its wavelength. **(PP)**

Working and Answer:
Using the wave equation $\lambda = \dfrac{v}{f}$.
Substituting the values: $\lambda = \dfrac{343\,\text{m/s}}{440\,\text{Hz}} \approx 0.780\,\text{m}$.
Answer: $0.780\,\text{m}$

7. Calculate the energy of a photon with a frequency of $5 \times 10^{14}\,\text{Hz}$. (Use $E = hf$ and $h = 6.63 \times 10^{-34}\,\text{J s}$) **(PP)**

Working and Answer:
Using the equation $E = hf$.
Substituting the values:
$E = (6.63 \times 10^{-34}\,\text{J s}) \times (5 \times 10^{14}\,\text{Hz}) = 3.315 \times 10^{-19}\,\text{J}$.
Answer: $3.315 \times 10^{-19}\,\text{J}$

8. A light wave has a wavelength of 400 nm. Calculate its frequency. (Use $c = 3 \times 10^8$ m/s) **(PP)**

Working and Answer:
First, convert 400 nm to meters: $400\,\text{nm} = 400 \times 10^{-9}\,\text{m}$.
Using the wave equation $f = \dfrac{c}{\lambda}$.
Substituting the values: $f = \dfrac{3 \times 10^8\,\text{m/s}}{400 \times 10^{-9}\,\text{m}} = 7.5 \times 10^{14}\,\text{Hz}$.
Answer: 7.5×10^{14} Hz

9. A photon has an energy of $2.48 \times 10^{-19}\,\text{J}$. Calculate its frequency. (Use $h = 6.63 \times 10^{-34}\,\text{J s}$) **(PP)**

Working and Answer:

Using the equation $f = \dfrac{E}{h}$.

Substituting the values: $f = \dfrac{2.48 \times 10^{-19}\,\text{J}}{6.63 \times 10^{-34}\,\text{J s}} \approx 3.74 \times 10^{14}\,\text{Hz}$.

Answer: $3.74 \times 10^{14}\,\text{Hz}$

10. A wave has a frequency of 60 Hz and a wavelength of 1.5 m. Calculate its speed. **(PP)**

Working and Answer:
Using the wave equation $v = f\lambda$.
Substituting the values: $v = 60\,\text{Hz} \times 1.5\,\text{m} = 90\,\text{m/s}$.
Answer: $90\,\text{m/s}$

11. A laser emits light with a wavelength of 650 nm. Calculate the energy of one photon of this light. **(PPP)**

Working and Answer:
First, convert 650 nm to meters: $650\,\text{nm} = 650 \times 10^{-9}\,\text{m}$.
Using the wave equation to find frequency:
$f = \dfrac{c}{\lambda} = \dfrac{3 \times 10^{8}\,\text{m/s}}{650 \times 10^{-9}\,\text{m}} \approx 4.615 \times 10^{14}\,\text{Hz}.$
Now, using $E = hf$: $E = (6.63 \times 10^{-34}\,\text{J s}) \times (4.615 \times 10^{14}\,\text{Hz}) \approx 3.06 \times 10^{-19}\,\text{J}$.
Answer: $3.06 \times 10^{-19}\,\text{J}$

12. A wave travels at a speed of 250 m/s and has a frequency of 50 Hz. What is its wavelength? **(PPP)**

Working and Answer:
Using the wave equation $\lambda = \frac{v}{f}$.
Substituting the values: $\lambda = \frac{250\,\text{m/s}}{50\,\text{Hz}} = 5\,\text{m}$.
Answer: 5 m

13. Calculate the wavelength of a photon with an energy of $1.24 \times 10^{-19}\,\text{J}$. (Use $h = 6.63 \times 10^{-34}\,\text{J s}$) **(PPP)**

Working and Answer:
Using the equation $E = hf$ to find frequency:
$f = \dfrac{E}{h} = \dfrac{1.24 \times 10^{-19}\,\text{J}}{6.63 \times 10^{-34}\,\text{J s}} \approx 1.87 \times 10^{14}\,\text{Hz}.$
Now, using $\lambda = \dfrac{c}{f}$: $\lambda = \dfrac{3 \times 10^{8}\,\text{m/s}}{1.87 \times 10^{14}\,\text{Hz}} \approx 1.60 \times 10^{-6}\,\text{m}.$
Answer: $1.60 \times 10^{-6}\,\text{m}$

14. A sound wave has a speed of 340 m/s and a wavelength of 0.85 m. Calculate its frequency. **(PPP)**

Working and Answer:
Using the wave equation $f = \dfrac{v}{\lambda}$.
Substituting the values: $f = \dfrac{340\,\text{m/s}}{0.85\,\text{m}} \approx 400\,\text{Hz}$.
Answer: 400 Hz

15. A light wave has a frequency of $3 \times 10^{15}\,\text{Hz}$. Calculate its wavelength in a vacuum. (Use $c = 3 \times 10^{8}\,\text{m/s}$) **(PPP)**

Working and Answer:
Using the wave equation $\lambda = \dfrac{c}{f}$.
Substituting the values: $\lambda = \dfrac{3 \times 10^{8}\,\text{m/s}}{3 \times 10^{15}\,\text{Hz}} = 1 \times 10^{-7}\,\text{m}$.
Answer: $1 \times 10^{-7}\,\text{m}$

16. A photon has a frequency of 4.0×10^{14} Hz. Calculate its energy. (Use $h = 6.63 \times 10^{-34}$ J s) **(PPPP)**

Working and Answer:
Using the equation $E = hf$.
Substituting the values:
$E = (6.63 \times 10^{-34}\,\text{J s}) \times (4.0 \times 10^{14}\,\text{Hz}) = 2.652 \times 10^{-19}\,\text{J}$.
Answer: 2.652×10^{-19} J

17. A wave has a speed of 300 m/s and a frequency of 75 Hz. Calculate its wavelength. **(PPPP)**

Working and Answer:
Using the wave equation $\lambda = \dfrac{v}{f}$.
Substituting the values: $\lambda = \dfrac{300\,\text{m/s}}{75\,\text{Hz}} = 4\,\text{m}$.
Answer: 4 m

18. A light wave has a wavelength of 500 nm. Calculate its frequency. (Use $c = 3 \times 10^8$ m/s) **(PPPP)**

Working and Answer:
First, convert 500 nm to meters: $500\,\text{nm} = 500 \times 10^{-9}\,\text{m}$.
Using the wave equation $f = \dfrac{c}{\lambda}$.
Substituting the values: $f = \dfrac{3 \times 10^8\,\text{m/s}}{500 \times 10^{-9}\,\text{m}} = 6 \times 10^{14}\,\text{Hz}$.
Answer: 6×10^{14} Hz

19. A photon has an energy of $3.2 \times 10^{-19}\,\text{J}$. Calculate its wavelength. (Use $h = 6.63 \times 10^{-34}\,\text{J s}$) **(PPPP)**

Working and Answer:

Using the equation $f = \dfrac{E}{h}$: $f = \dfrac{3.2 \times 10^{-19}\,\text{J}}{6.63 \times 10^{-34}\,\text{J s}} \approx 4.82 \times 10^{14}\,\text{Hz}$.

Now, using $\lambda = \dfrac{c}{f}$: $\lambda = \dfrac{3 \times 10^{8}\,\text{m/s}}{4.82 \times 10^{14}\,\text{Hz}} \approx 6.22 \times 10^{-7}\,\text{m}$.

Answer: $6.22 \times 10^{-7}\,\text{m}$

20. A sound wave has a frequency of 1000 Hz and a wavelength of 0.34 m. Calculate its speed. **(PPPP)**

Working and Answer:
Using the wave equation $v = f\lambda$.
Substituting the values: $v = 1000\,\text{Hz} \times 0.34\,\text{m} = 340\,\text{m/s}$.
Answer: $340\,\text{m/s}$

21. A light wave has a frequency of $2.5 \times 10^{15}\,\text{Hz}$. Calculate its energy. (Use $h = 6.63 \times 10^{-34}\,\text{J s}$) **(PPPPP)**

Working and Answer:
Using the equation $E = hf$.
Substituting the values:
$E = (6.63 \times 10^{-34}\,\text{J s}) \times (2.5 \times 10^{15}\,\text{Hz}) = 1.6575 \times 10^{-18}\,\text{J}$.
Answer: $1.6575 \times 10^{-18}\,\text{J}$

22. A wave has a speed of 500 m/s and a wavelength of 2 m. Calculate its frequency. **(PPPPP)**

Working and Answer:
Using the wave equation $f = \dfrac{v}{\lambda}$.
Substituting the values: $f = \dfrac{500\,\text{m/s}}{2\,\text{m}} = 250\,\text{Hz}$.
Answer: 250 Hz

23. A photon has a wavelength of 300 nm. Calculate its energy. (Use $h = 6.63 \times 10^{-34}$ J s and $c = 3 \times 10^8$ m/s) **(PPPPP)**

Working and Answer:
First, convert 300 nm to meters: $300\,\text{nm} = 300 \times 10^{-9}\,\text{m}$.
Using the wave equation to find frequency:
$$f = \frac{c}{\lambda} = \frac{3 \times 10^8\,\text{m/s}}{300 \times 10^{-9}\,\text{m}} = 1 \times 10^{15}\,\text{Hz}.$$
Now, using $E = hf$: $E = (6.63 \times 10^{-34}\,\text{J s}) \times (1 \times 10^{15}\,\text{Hz}) = 6.63 \times 10^{-19}\,\text{J}$.
Answer: 6.63×10^{-19} J

24. A sound wave travels at a speed of 340 m/s and has a frequency of 680 Hz. Calculate its wavelength. **(PPPPP)**

Working and Answer:
Using the wave equation $\lambda = \dfrac{v}{f}$.
Substituting the values: $\lambda = \dfrac{340\,\text{m/s}}{680\,\text{Hz}} = 0.5\,\text{m}$.
Answer: $0.5\,\text{m}$

25. A light wave has a frequency of $5 \times 10^{14}\,\text{Hz}$. Calculate its wavelength in a vacuum. (Use $c = 3 \times 10^{8}\,\text{m/s}$) **(PPPPP)**

Working and Answer:
Using the wave equation $\lambda = \dfrac{c}{f}, \lambda = \dfrac{3 \times 10^{8}\,\text{m/s}}{5 \times 10^{14}\,\text{Hz}} =$
$6 \times 10^{-7}\,\text{m}$. Answer: $6 \times 10^{-7}\,\text{m}$