Shedding Light on Electromagnetic Waves  

Name: _____________________________________

1. Fill in the diagram.

   ![](diagram.png)

   - Electric field (up and down)
   - Magnetic field (out of the page and into the page)

2. \(10^4 = \) ________________  \(10^8 = \) ________________

3. Electricity and magnetism are related. We know this because moving a magnet in a coil of wire produces ________________ and an electric current flowing in a coil of wire produces ________________.

4. In the 1860s, James Clerk Maxwell used the data of many experiments to come up with a set of equations which suggested to him that light is an ____________-field wave combined with a ____________-field wave.

5. Draw a “3D” electromagnetic wave showing the electric-field wave moving up and down and the magnetic-field wave moving “out of” the page and “into” the page.

   ![](3D_diagram.png)

6. Name three types of waves (other than electromagnetic waves).

7. Using a simple slinky diagram, like the one shown at right, draw:

   - a transverse wave
   - a longitudinal wave

(c) Use arrows in your diagrams above to show (a) which way each loop moves and (b) in which direction the wave is moving.

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Part A

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Part B

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Part C

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8. All waves, except electromagnetic waves, need a medium to travel through. What is a “medium”? Give two examples.

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
Label the diagram.

9. In the diagram of the wave above, \( \lambda = \) ________cm, while the amplitude = ________cm.

10. Two wave pulses head towards each other on a slinky. Draw what the wave pulses will look like when the two waves meet, and what they will look like after they meet.

__________________________________________________________________________

11. What is the frequency (f) of a wave? What is the unit for frequency?

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

speed = distance/time \quad time = distance/speed \quad speed_{\text{light}} = 300,000\text{km/s} \quad speed_{\text{sound}} = 340\text{m/s} = 0.340\text{km/s}

(your units for distance and speed must match: if you use km/s, your distance must be in km)

12. The length of the Earth’s equator is about 40,000km. Calculate the time it would take for a light beam and a sound wave to travel…

(a) around the world once.

Light

Sound

(b) to the moon. (the Earth-Moon distance = 378,000km)

Light

Sound

13. Why do you often hear a thunder clap sometime after you see the lightning?

__________________________________________________________________________
__________________________________________________________________________

14. How does a change in frequency of a wave affect its speed? (Hint: TRICK QUESTION)
15. For any given type of wave, a lower frequency results in a _______________ wavelength.

16. Fill in the table using the wave equation: wave speed = frequency x wavelength
   frequency = wave speed / wavelength   wavelength = wave speed / frequency

<table>
<thead>
<tr>
<th>Wave</th>
<th>Speed, s (m/s)</th>
<th>Frequency, f (Hz)</th>
<th>Wavelength, λ (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound in 15°C air</td>
<td>256</td>
<td></td>
<td>1.33</td>
</tr>
<tr>
<td>Sound in 30°C air</td>
<td>349</td>
<td>256</td>
<td></td>
</tr>
<tr>
<td>He-Ne Laser beam</td>
<td>300,000,000</td>
<td>633 x 10^-9</td>
<td></td>
</tr>
<tr>
<td>Nova FM’s broadcast signal</td>
<td>300,000,000 (100.3MHz)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

17. Fill in the table.

<table>
<thead>
<tr>
<th>Commonly Used Unit Prefixes</th>
<th>Prefix</th>
<th>Letter</th>
<th>Standard Form</th>
<th>Meaning (in English)</th>
<th>Decimal/Numeric</th>
</tr>
</thead>
<tbody>
<tr>
<td>pico-</td>
<td>p</td>
<td>10^-12</td>
<td>1 trillionth</td>
<td>0.000 000 000 001</td>
<td></td>
</tr>
<tr>
<td>nano-</td>
<td>n</td>
<td>10^-9</td>
<td>1 billionth</td>
<td>0.000 000 001</td>
<td></td>
</tr>
<tr>
<td>micro-</td>
<td>μ</td>
<td></td>
<td>10^-6</td>
<td>0.000 001</td>
<td></td>
</tr>
<tr>
<td>milli-</td>
<td>m</td>
<td>10^-3</td>
<td>1 one hundredth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>centi-</td>
<td>c</td>
<td>10^-2</td>
<td>1 one hundredth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(no prefix)</td>
<td></td>
<td>10^0</td>
<td>1 one hundredth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>kilo-</td>
<td>k</td>
<td></td>
<td>10^3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>mega-</td>
<td>G</td>
<td>10^6</td>
<td>billion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>giga-</td>
<td>T</td>
<td>10^12</td>
<td>quadrillion</td>
<td>1000,000,000,000,000</td>
<td></td>
</tr>
</tbody>
</table>

18. Rewrite the following using the correct symbols. The first two have been done for you.
   (a) 100 picometres: 100pm
   (b) 450 gigahertz: 450GHz
   (c) 300 megahertz: ______________
   (d) 750 nanometres: ______________
   (e) 2 micrometres: ______________
   (f) 400 terahertz: ______________

19. How are radio waves generated?

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

20. If a carrier wave looked like this,
and the audio signal looked like this,

draw the amplitude-modulated (AM) wave that an AM radio station would transmit. (Draw it just below the audio signal.)
21. FM stands for ___________________ ________________________.
22. Compare and contrast an analogue transmission with a digital transmission.

____________________________________________________________________________________

____________________________________________________________________________________

23. Explain briefly how a microwave oven heats food.

____________________________________________________________________________________

____________________________________________________________________________________

24. Why is infrared light often called radiant heat?

____________________________________________________________________________________

____________________________________________________________________________________

25. Apart from the hot flames themselves, bush fires (or forest fires) present two other immediate hazards to humans: ___________________ and ___________________.

26. Cold objects produce ________________ frequency infrared light, while hotter objects produce ________________ frequency infrared light.

27. Describe the operation of a thermal imaging camera.

____________________________________________________________________________________

____________________________________________________________________________________

28. Describe one use of thermography.

____________________________________________________________________________________

____________________________________________________________________________________

29. What is incandescence?

____________________________________________________________________________________

____________________________________________________________________________________

30. In the visible spectrum, red light has the ______________ frequency and the ______________ wavelength.

31. How are lasers different to other light sources?

____________________________________________________________________________________

____________________________________________________________________________________

32. Label the diagram.

Part E

Composition of Sunlight

____________________________________________________________________________________

____________________________________________________________________________________

Part F

Composition of Sunlight
Hitting the Earth’s Surface
(having passed through the atmosphere)

(please note: The Earth’s atmosphere depicted in the diagram is hugely exaggerated. A scale diagram depicting Earth with a 2cm diameter should have an atmosphere only 0.16mm deep.)
33. List some of the hazards associated with overexposure to UV.
______________________________________________________________________________________
______________________________________________________________________________________
______________________________________________________________________________________

34. What does SPF30+ mean?
______________________________________________________________________________________
______________________________________________________________________________________
______________________________________________________________________________________

35. Draw a diagram showing the position of the X-ray machine, the body part, and the film (or electronic sensor) when an X-ray photo is taken. Explain what happens.
______________________________________________________________________________________
______________________________________________________________________________________
______________________________________________________________________________________
______________________________________________________________________________________
______________________________________________________________________________________
______________________________________________________________________________________

36. Large doses of X-rays can kill cells. How can this ability be put to good use?
______________________________________________________________________________________
______________________________________________________________________________________
______________________________________________________________________________________

37. Of all electromagnetic waves, gamma rays have the _____________ frequency and the _____________ wavelength.

38. Steel slabs can be made into thinner sheets by heating them and then feeding them through huge rollers. The rollers can be moved closer together (with a machine) to produce a thinner sheet or moved further apart to produce a thicker sheet. Describe how a gamma ray system can be used to automatically control the thickness of the sheet.
______________________________________________________________________________________
______________________________________________________________________________________
______________________________________________________________________________________
______________________________________________________________________________________
______________________________________________________________________________________