Student #: _____ Student Name: _____

Grade 12 Physics Class 13: Applications of EM Waves

_____ 1. Thin films of soap sometime display an array of colours. This display is the result of:

(a) reflection, diffraction, and interference
(b) reflection, refraction, and interference
(c) reflection, refraction, and polarization
(d) refraction, interference, and polarization
(e) reflection, interference, and polarization

_____ 2. A beam of light is unpolarized. This means that:

(a) vibrations are confined to a single plane
(b) vibrations are occurring in all possible directions
(c) vibrations are occurring in all directions perpendicular to the direction of light propagation
(d) light has reflected from a horizontal surface
(e) light has passed through a calcite crystal which causes double refraction

_____ 3. Green light is shone onto two soap films. An observer looking down at the soap films sees that soap film X appears uniformly green while soap film Y has equally spaced green and black bands. If air is the medium on either side of the soap film, the best explanation of this pattern is that:

(a) film X has a thickness much less than λ and film Y has a thickness of $\lambda/4$
(b) film X has a thickness of $\lambda/2$ and film Y has a thickness of $\lambda/4$
(c) film X has a thickness of $\lambda/4$ and film Y has a thickness of $\lambda/2$
(d) film X has consistent thickness throughout whereas film Y has variable thickness
(e) film X has variable thickness whereas film Y has consistent thickness throughout

_____ 4. Which of the following correctly describes the motion of the electric and magnetic fields of a microwave transmitted by a cell phone?

(a) Both the electric and magnetic fields oscillate in the same plane and perpendicular to the direction of wave propagation.
(b) Both the electric and magnetic fields oscillate perpendicular to each other and to the direction of wave propagation.
(c) The electric field oscillates perpendicular to the direction of wave propagation. The magnetic field oscillates parallel to the direction of wave propagation.
(d) Both the electric and magnetic fields oscillate parallel to the direction of wave propagation.

5. The newest reconnaissance (i.e. spy) satellites can resolve objects separated by only $3.0\,\text{cm}$. If one of these satellites orbits Earth at low orbital altitude of $250\,\text{km}$,
   (a) Determine the size of the satellites' circular imaging aperture. (Use $455\,\text{nm}$ light for the light in the lenses of the satellites.)
   (b) Describe why the value from part (a) is a theoretical best-case result. What other effects would play a role in a satellites ability to resolve objects on the surface of Earth?

6. A skydiver is falling towards the ground. How close to the ground will she have to be before she is able to distinguish two yellow baseballs lying $25.0\,\text{cm}$ apart, reflecting $570\,\text{nm}$ light in air? Her pupil diameter is $3.35\,\text{mm}$. Assume that the speed of light inside the human eye is $2.21 \times 10^8\,\text{m/s}$.

7. The telescope on Mount Palomar has a diameter of $200\,\text{in}$ ($1\,\text{in} = 2.54 \times 10^{-2}\,\text{m}$). Suppose a double star were $4.0\,\text{ly}$ (light years) away. Under ideal conditions, what must be the minimum separation of the 2 stars for their image to be resolved? (Use a wavelength of $400\,\text{nm}$.)

8. For a ruby laser of wavelength $694\,\text{nm}$, the end of the ruby crystal is the aperture that determines the diameter of the light beam emitted. If the diameter is $1.50\,\text{cm}$ and the laser is aimed at the moon, find the approximate diameter of the light beam when it reaches the moon, assuming the spread is due solely to diffraction?

9. Microwaves operate at a frequency of $2.40\,\text{GHz}$. Find the minimum thickness for a plastic tray with a refractive index of 1.45 that will cause enhanced reflection of microwaves incident normal to the tray. (The speed of microwaves is $3.00 \times 10^8\,\text{m/s}$.)

10. White light shines on a $250\,\text{nm}$ thick layer of diamond ($n = 2.42$). What wavelength of *visible light* is most strongly reflected?

11. As a soap bubble ($n = 1.333$) evaporates and thins, the reflected colours gradually disappear.
    (a) What is the thickness as the last vestige of colour vanishes?
    (b) What is the last colour seen?

12. News media often conduct live interviews from locations halfway around the world. There is obviously a time-lag between when a signal is sent and when it is received.
    (a) Calculate how long the time-lag should be for a signal sent from locations on Earth separated by 2.00×10^4 km.
    (b) Suggest reasons why the actual time-lag differs from the value in (a).