

Electricity, Magnetism and Light  
Test 2, 2018, No calculators.  
Exam time: 50 min.  
Exam, Form: A

Name: \_\_\_\_\_

Student Number: \_\_\_\_\_

TA: \_\_\_\_\_

Date: \_\_\_\_\_

### Section 1. Matching of scientific terms and concepts (5 pts.)

- |                  |   |
|------------------|---|
| _____ prodigious | (a) made necessary by particular circumstances or regulations   |
| _____ vulgar     | (b) a medical condition with yellowing of the skin or whites of the eyes                                |
| _____ contiguous | (c) prove (a person or an assertion) to be wrong  |
| _____ tourmaline | (d) a typically black or blackish mineral that occurs as prismatic crystals in granitic and other rocks |
| _____ porous     | (e) a former measure of distance by land, usually about three miles                                     |
| _____ educe      | (f) attribute something to (a cause)  |
| _____ discourse  | (g) having minute spaces or holes through which liquid or air may pass                                  |
| _____ coronae    | (h) the quality of being open and honest in expression  |
| _____ feign      | (i) written or spoken communication or debate   |
| _____ azure      | (j) bright blue in color, like a cloudless sky  |
| _____ league     | (k) bring out or develop (something latent or potential)  |
| _____ jaundice   | (l) (of a subject or knowledge) little known; abstruse  |
| _____ ascribe    | (m) sharing a common border; touching   |
| _____ recondite  | (n) round or spherical  |
| _____ aqueous    | (o) positioned in or relating to the sky, or outer space as observed in astronomy                       |
| _____ confute    | (p) characteristic of or belonging to the masses  |
| _____ rotund     | (q) pretend to be affected by   |
| _____ candour    | (r) of or containing water, typically as a solvent or medium  |
| _____ celestial  | (s) a small circle of light seen around the sun or moon   |
| _____ requisite  | (t) remarkably or impressively great in extent, size, or degree   |

## Section 2. Multiple choice (16 pts.)

1. Fermat's principle states that the trajectory of a ray of light leaving a source at one location and arriving at another location is the trajectory that
  - (a) minimizes the total time of transit between the two locations
  - (b) conserves the energy of the light beam
  - (c) obeys the law of reflection
  - (d) is the most simple
  - (e) none of the above
2. When a capital letter, drawn on a piece of paper, is viewed through a crystal of Iceland spar, two images of the letter appear side by side. This would -not- happen if
  - (a) light was a longitudinal wave
  - (b) light was a perfectly spherical particle
  - (c) Iceland spar was a symmetric crystal
  - (d) all of the above
  - (e) none of the above
3. Descartes' measurement of the speed of light failed because
  - (a) the mirror was not rotating fast enough
  - (b) our moon is too close to the earth
  - (c) Jupiter moves too quickly
  - (d) light is not a particle
  - (e) actually, Descartes was successful in measuring the speed of light
4. A scientist attempts to make two glass plates perfectly parallel to one another, separated by a thin air gap. To test whether they are parallel, the scientist shines a red light on the plates from above. He sees four equally spaced parallel interference fringes on the surface of the glass plates. This means that the plates are
  - (a) parallel
  - (b) not parallel; the air gap width varies by about 1 nanometer between opposite edges
  - (c) not parallel; the air gap width varies by about 1 micrometer between opposite edges
  - (d) not parallel; the air gap width varies by about 1 millimeter between opposite edges
  - (e) not parallel; the air gap width varies by about 1 centimeter between opposite edges
5. A Keplerian telescope is constructed using a 200 cm focal length objective lens and a 2 cm focal length eyepiece lens. To observe the distant stars, what should be the (approximate) length of this telescope, from objective to eyepiece?
  - (a) 0.20 meters
  - (b) 2.00 meters
  - (c) 2.02 meters
  - (d) 2.20 meters
  - (e) none of the above

6. If the heat generated by burning 0.06 pounds of carbon is required to raise 80 pounds of water by 6 degrees celsius, then how much carbon must be burned to raise 40 pounds of water by 4 degrees celsius?
- (a) 0.001 lbs
  - (b) 0.004 lbs
  - (c) 0.01 lbs
  - (d) 0.02 lbs
  - (e) none of the above
7. In his six lectures on light, Tyndall describes Faraday's experiment on the rotation of a polarized light beam. Faraday was able to rotate light's polarization by passing polarized light through
- (a) a magnetic field
  - (b) a sheet of mica
  - (c) cellophane tape
  - (d) stressed plexiglass
  - (e) an electric field
8. A Keplerian telescope is constructed using a 200 cm focal length objective lens and a 2 cm focal length eyepiece lens. What is the (approximate) magnification of this telescope?
- (a) 5 times
  - (b) 10 times
  - (c) 100 times
  - (d) 200 times
  - (e) none of the above
9. Relaxing on a beach in Mexico, you put on your new pair of cheap polarized sunglasses. Looking seaward, you notice a lot of glare (a lot of sunlight reflecting from the surface of the sea). When you write a letter of complaint to the manufacturer, you might suggest that they
- (a) orient the polarizing filters horizontally instead of vertically
  - (b) orient the polarizing filters vertically instead of horizontally
  - (c) orient the polarizing filters diagonally
  - (d) use crossed filters
  - (e) use mica filters
10. As in lab, a laser beam is fired into a cuvette full of milky fluid. Before striking the cuvette, however, the beam is passed through a polarizer oriented so that *only vertically polarized* light (perpendicular to the table's surface) strikes the fluid. In this case, *no light at all* is scattered
- (a) directly above the cuvette
  - (b) directly to the right or left of the cuvette
  - (c) directly back towards the laser from the cuvette
  - (d) directly forward from the cuvette
  - (e) actually, light is scattered in all these directions, but it is polarized in some directions

11. Suppose that a ray of light passes from a vacuum into a newly discovered material brought back to earth from an asteroid. It is found that the ray of light, when entering the new material, bends *away* from a line drawn normal (perpendicular) to the surface. This would make sense if
- (a) light was, in fact, a particle, not a wave
  - (b) the refractive index of the material was less than one
  - (c) the speed of light in the material was greater than the speed of light in vacuum
  - (d) all of the above would explain this phenomenon
  - (e) none of the above
12. Suppose that a toy gun uses a compressed spring to fire small bullets. The spring (whose spring constant is  $k = 1$  Newton/meter) is compressed by one centimeter. A 10-gram bullet is placed in the gun and the gun is fired horizontally. What is the speed of the bullet when it leaves the spring. (You may ignore any gravitational or frictional effects.)
- (a) 1 cm/sec
  - (b) 10 cm/sec
  - (c) 100 cm/sec
  - (d) 10 m/s
  - (e) none of the above
13. A red laser beam is shone on a 100 micron thick fiber of wool. Interference fringes are observed on a screen behind the fiber. What is the approximate sine of the angle between the central bright fringe and the fringe immediately to the right of the central fringe?
- (a) 6/1000
  - (b) 3/100
  - (c) 3/10
  - (d) 1/10
  - (e) 1
14. A ray of light strikes the surface of a glass cube at an oblique angle. The light ray passes through the cube and leaves through the opposite face of the cube. Which of the following must be true?
- (a) the ray leaving the cube is parallel to the ray entering the cube
  - (b) the ray inside the cube is parallel to the ray leaving the cube
  - (c) the wavelength of the ray inside the cube is greater than the wavelength of the ray entering the cube
  - (d) the frequency of the ray entering the cube is greater than the frequency of the ray inside the cube
  - (e) all of the above are, in fact, true
15. Two vertical organ pipes emit the same note, having a wavelength of one meter. The pipes are exactly two meters apart. Surprisingly, the note coming from one pipe is exactly 180 degrees out of phase with the note coming from the other pipe. If you walk in a circle around the pipes once, how many points of constructive interference will you encounter?
- (a) 4
  - (b) 8
  - (c) 12
  - (d) 16
  - (e) none of the above

16. Mirages appear in the desert because

- (a) the air near the ground is considerably colder than the air above it
- (b) the air near the ground is considerably warmer than the air above it
- (c) the refractive index of air is independent of temperature
- (d) Genies create them using magic
- (e) actually, mirages don't occur nowadays



#### Section 4. Essay question (2 pts.)

Answer the following two short essay questions. You should employ neat handwriting, logical and relevant argumentation, and correct grammar, spelling and punctuation.

1. Why is the sky blue?

2. Why does the moon look blood-red during a lunar eclipse? For that matter, why is the moon visible at all during a lunar eclipse? (after all: it should be in Earth's shadow, right?)