

Physics 2020-002 Exam 3

Constants and Formulae

$$G = 6.673 \times 10^{-11} \text{ N m}^2 / \text{kg}^2$$

$$h = 6.62620 \times 10^{-34} \text{ J s}$$

$$c = 2.997925 \times 10^8 \text{ m/s}$$

$$\sigma = 5.6696 \times 10^{-8} \text{ W}/(\text{m}^2 \text{ K}^4)$$

$$R_{\odot} = 6.96 \times 10^8 \text{ m}$$

$$g = 9.80 \text{ m/s}^2$$

$$I_{\text{th}} = 1.00 \times 10^{-12} \text{ W/m}^2$$

$$I_{\text{tp}} = 1.00 \text{ W/m}^2$$

$$1 \text{ eV} = 1.60219 \times 10^{-19} \text{ J}$$

$$1 \text{ T} = 10^4 \text{ G}$$

$$1 \text{ km} = 10^3 \text{ m}$$

$$1 \text{ nm} = 10^{-9} \text{ m}$$

$$1 \text{ min} = 60 \text{ s}$$

$$1 \text{ hr} = 3600 \text{ s}$$

$$\text{KE} \equiv \frac{1}{2}mv^2$$

$$\text{PE}_s = \frac{1}{2}kx^2$$

$$\text{KE}_i + \text{PE}_i = \text{KE}_f + \text{PE}_f$$

$$E = \text{KE} + \text{PE}$$

$$F_s = -kx$$

$$L = (n/2)\lambda \quad (n = 1, 2, 3, \dots)$$

$$T = 1/f = 2\pi\sqrt{m/k}$$

$$T = 2\pi\sqrt{L/g}$$

$$\beta = 10 \log(I/I_{\odot})$$

$$I = \mathcal{P}/(4\pi r^2)$$

$$\omega = 2\pi f$$

$$f_n = nf_1$$

$$1/\lambda_n = R_A Z^2/n^2$$

$$\nu = c/\lambda$$

$$L/L_{\odot} = (R/R_{\odot})^2 (T/T_{\odot})^4$$

$$F = \sigma T^4$$

$$E = h\nu = hc/\lambda$$

$$L = 4\pi\sigma R^2 T^4$$

$$v = (331.3 \text{ m/s})\sqrt{T/273 \text{ K}} = f\lambda$$

$$\lambda_{\text{max}} = (2.897 \times 10^{-3} \text{ m K})/T$$

Exam 3A – 5 April 2010

Part A: Hard Multiple Choice (10 points total, 2 points each, Circle Best Answer).

1. A photon has an energy of 0.512 eV. What is the wavelength of this photon?

- a) 91.22 nm b) 6563 Å c) 1.24×10^5 m
d) 2.58×10^{14} Å e) 2422 nm

2. A 26.8 cm long piano wire is oscillating at the second harmonic. What is the wavelength of this oscillation?

- a) 6.70 cm b) 13.4 cm c) 26.8 cm d) 53.6 cm e) 107 cm

3. A 1.79 kg mass is connected to a spring and following simple harmonic motion. When the mass is 0.242 m from the equilibrium point, it experiences a force of -270 N. What is the spring constant of this spring?

- a) 4.13 N/m b) 5620 N/m c) 65.3 N/m
d) 1120 N/m e) 24.2 N/m

4. A sound wave is traveling at 350 m/s. What is the air temperature?

- a) 273 K b) 5800 K c) -28.4°F d) 59.6°C e) 305 K

5. What is wavelength of the Balmer limit for ionized helium? (Note that $R_{\text{He}} = 1.097223 \times 10^7 \text{ m}^{-1}$ and helium has an atomic number of 2.)

- a) 22.78 nm b) 91.14 nm c) 364.6 nm d) 656.3 nm e) 820.3 nm
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Part B: Easy Multiple Choice (10 points total, 1 point each, Circle Best Answer).

6. Particles with symmetric wavefunctions are called

- a) bosons b) electrons c) quarks d) fermions e) leptons

7. Which of the following is a field particle?

- a) gluon b) electron c) quark d) proton e) phonon

8. Last week, our guest lecturer talked about the Cassini and Huygens spacecrafts. What is the name of the moon on which Huygens landed?

- a) Luna b) Europa c) Enceladus d) Titan e) Io

9. The “state” of a particle in classical physics can be given by the particle’s

- a) mass b) charge c) spin
d) trajectory e) probability

10. Strong spectral lines that originate out of the ground state are called

- a) forbidden lines b) semiforbidden lines c) intersystem lines
d) resonance lines e) none of these

11. Helium nuclei are also called what type of particles?

- a) alpha b) beta c) gamma d) boson e) lepton

12. Frequencies produced by either a horn or string instrument that are integer numbers multiplied by the fundamental frequency are called

- a) tuners b) singing c) wave numbers d) harmonics e) voltages

13. Which of the following is the true statement about hadrons?

- a) Hadrons are all leptons.
- b) Hadrons are particles that obey the strong force.
- c) Hadrons are particles that obey the dark side of the force.
- d) Hadrons obey the weak, electromagnetic, and gravitational forces, but they do not obey the strong force since they do not “see” gluons.
- e) None of these are true.

14. Brightness of visible light is to color as loudness of sound is to

- a) density
- b) pressure
- c) flux
- d) intensity
- e) pitch

15. The Pauli Exclusion Principle only applies to what type of particles?

- a) bosons
 - b) photons
 - c) fermions
 - d) gravitons
 - e) mesons
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Part C: Problems (20 points total, 10 points each).

16. The 4th brightest star in the night sky is Arcturus which has an effective temperature of 4250 K and a luminosity of 170 times the brightness of the Sun. (a) What is the radius of this star in solar radii? (b) At what wavelength (in nm) does it emit most of its light? (c) What is the energy flux of this star at its surface? (Note that the effective temperature of the Sun is 5880 K. **Show all work!!!**)

17. A 5.88 kg mass is connected to a spring and set into oscillation with a period of 2.86 s on a frictionless horizontal surface. Whenever this mass passes through the system's equilibrium position, its velocity has an absolute value of 13.3 m/s. (a) What is the total energy of this system? (b) What is the spring constant of the spring? (*Hint:* How does the period relate to the mass and spring constant?) (c) What is the amplitude of this oscillation? (**Show all work!!!**)

Extra Credit Problem (5 points, do this only if you have time).

18. A pendulum has a period 14.4 s on Earth. This same pendulum is taken to the Mars and set into oscillation. Its period on Mars is 23.1 s. What is the surface gravity on Mars? (**Show all work!**)