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Principles of Physics II
PHY1322
PHY1302

Instructor: Dr. Andrzej Czajkowski
Supplementary Final Exam
April 17 2008

Closed book exam
ANSWER ALL QUESTIONS
Duration: 3 hrs

RETURN ONLY SCANTRON SHEETS!

Harmonic Oscillator

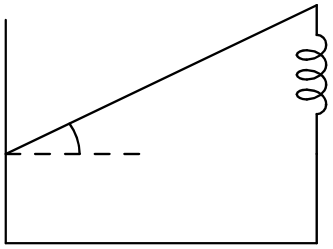
1. The crucial requirement for an object that is part of a mechanical oscillator system is as follows: when acted on by a net force produced by other elements of the system is that the force be____

a. in the same direction as the velocity of the object.
b. in the same direction as the displacement of the system.
c. in the same direction as the acceleration of the system.
d. opposite in direction to the displacement of the object.
e. opposite in direction to the velocity of the object.

2. A uniform rod (length $L = 1.0$ m, mass $= 2.0$ kg) is suspended from a pivot a distance $d = 0.25$ m above its center of mass. The angular frequency in rad/s for small oscillations is approximately
a. 1.0. b. 2.2. c. 1.5. **d. 4.1.** e. 3.5.

3. A horizontal plank ($m = 2.0$ kg, $L = 1.0$ m) is pivoted at one end. A spring $k = 1000$ N/m) is attached at the other end, as shown in the figure. Find the angular frequency in rad/s for small oscillations.

a. 39
b. 44
c. 55
d. 66
e. 25



Mechanical Waves

4. When a traveling wave reaches a boundary with a medium of greater density, the phase change in radians in the reflected wave is
a. 0. b. $\frac{\pi}{4}$. c. $\frac{\pi}{3}$. d. $\frac{\pi}{2}$. **e. π.**

5. A uniform cord has a mass of 0.6 kg and a length of 12 m. The tension in the cord is 19.6 N. What is the speed of a wave on the cord in m/s?
a. 9.9 b. 22.4 c. 4.5 **d. 19.8** e. 17.3

Electric Potential and Field

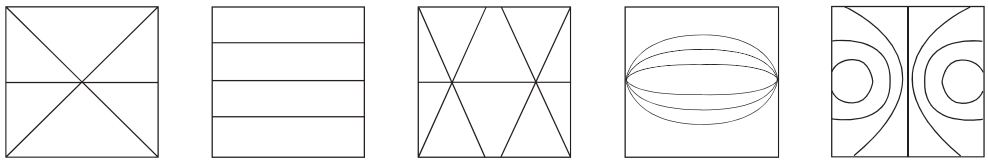
6. Two charges of 15 pC and –40 pC are inside a cube with sides that are of 0.40-m length. Determine the net electric flux through the surface of the cube.

a. $+2.8\ \text{N} \cdot \text{m}^2/\text{C}$
b. $-1.1\ \text{N} \cdot \text{m}^2/\text{C}$
c. $+1.1\ \text{N} \cdot \text{m}^2/\text{C}$
d. $-2.8\ \text{N} \cdot \text{m}^2/\text{C}$
e. $-0.47\ \text{N} \cdot \text{m}^2/\text{C}$

7 Three point charges are positioned on the x axis. If the charges and corresponding positions are +32 μC at x = 0, +20 μC at x = 40 cm, and –60 μC at x = 60 cm, what is the magnitude of the electrostatic force on the +32-μC charge?

a. 84 N **b. 12 N** c. 36 N d. 50 N e. 48 N

8 Which of the following represents the equipotential lines of a dipole?

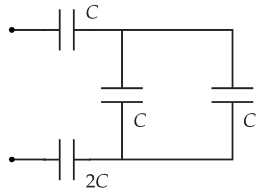


(a) (b) (c) (d) (e)

Correct answer E

Electric Circuits

9. Determine the equivalent capacitance of the combination shown when C = 12 pF.



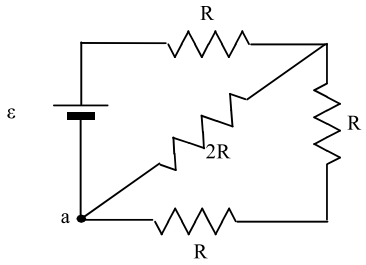
a. 48 pF b. 12 pF c. 24 pF **d. 6.0 pF** e. 59 pF

10. A light bulb is rated at 30 W when operated at 120 V. How much charge enters (and leaves) the light bulb in 1.0 min?

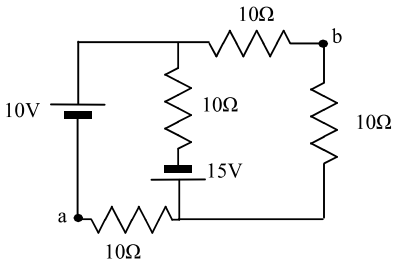
a. 17 C **b.15 C** c.14 C d. 13 C e. 60 C

11. At what rate is thermal energy being generated in the 2R-resistor when ε = 12 V and R = 3.0 Ω?

a. 12 W
b. 24 W
c. 6.0 W
d. 3.0 W
e. 1.5 W



12. Determine the potential difference $V_a - V_b$ shown in the circuit below.



a. –5.0 V
b. +5.0 V
c. –10 V
d. +10 V
e. 0 V

Particle Physics and Astrophysics

13 Which force has an approximate range of 1 fm?

a. weak force b. electromagnetic force c. gravitational force
b. **strong force** e. coulomb force

14 Particles that interact through the strong force are called _____.
a. leptons b. hadrons c. baryons d. muons e.electrons

15 Baryons consist of _____.
a. three quarks b. one quark and one antiquark
b. three antiquarks d. antiquarks and one quark
e. two quarks and one antiquark

16. The red shift of a quasar indicates that it is moving radially away from the Earth at a speed of 0.50 *c*. What is the age of the universe if we assume that this quasar has moved at the same speed relative to earth since the Big Bang? ($H \approx 17\times10^{-3}\ \mathrm{m/s\cdot ly}$; $1\ \mathrm{ly} = 9.46\times10^{15}\ \mathrm{m}$.)

a. 59 y **b.** 8.8×10^{9} y c. 1.76×10^{10} y
d. 5.6×10^{17} y e. 8.3×10^{25} y

Geometric Optics:

17. An object is placed 15 cm in front of a diverging lens whose focal length is 12 cm. Where will the image be located (in cm)?

a. –6.7 b. –7.2 c. –0.15 d.–60 e. –5.0

18. An object 15 cm high is placed 15 cm in front of a convex mirror with a focal length of –10 cm. What is the image height (in cm)?

a. 2 b. 4 **c. 6** d. 8 e.30

19 A plano - convex lens made out of very thin clear plastic filled with air (n=1) was placed underwater where $n = 4/3$. The radius of radius of one of the lens surfaces is R = 2m. Neglecting the effects of the thin plastic walls find the q (the position of the image with respect to lens) for an object located at p=2m from the lens.

a. 1.33m b. 0.25m. c. -0.1 d. -0.25m **e. none of the above.**

Interference

20. A film of thickness t and index of refraction n_1 coats a surface with index of refraction n_2. When $n_1 < n_2$, the condition for destructive interference for reflected monochromatic light of wavelength λin air is

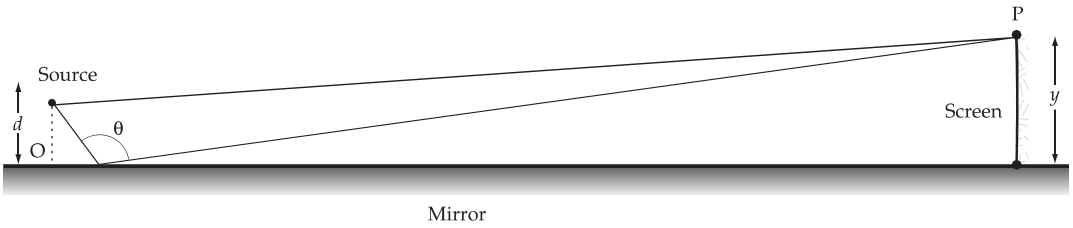
a. $t = m\dfrac{\lambda}{n_1}$. b. $t = \left(m + \dfrac{1}{2}\right)\dfrac{\lambda}{n_1}$. c. $2t = m\dfrac{\lambda}{n_1}$.

d. $2t = \left(m + \dfrac{1}{2}\right)\dfrac{\lambda}{n_1}$. e. $4t = m\dfrac{\lambda}{n_1}$.

21. In a double slit experiment, the distance between the slits is 0.2 mm and the distance to the screen is 150 cm. What is the phase difference (in degrees) between the waves from the two slits arriving at a point P when the angular distance of P is 10° relative to the central peak, and the wavelength is 500 nm? (Convert your result so the angle is between 0 and 360°.)

a. 145° b. 155° **c. 165°** d. 135° e. 95°

22. An interference pattern is produced at point P on a screen as a result of direct rays and rays reflected off a mirror as shown in the figure. If the source is 100 m to the left of the screen, 1 cm above the mirror, and the source is monochromatic (λ = 500 nm), find the conditions for minimum brightness on the screen in terms of λ, θ, and d.



a. $2d \sin\theta = (m + 1/2)\,\lambda$ **b. $2d \sin\theta = m\,\lambda$**
c. $d \sin\theta = (m + 1/2)\,\lambda$ d. $d \sin\theta = m\,\lambda$
e. none of these

23. A binary star system in the constellation Orion has an angular separation between the two stars of 1.2×10^{-5} radians. If $\lambda = 5 \times 10^{-7}$ m, what is the smallest aperture (diameter) telescope that may be used to resolve the two stars?

a. 10 cm **b.5 cm** c. 50 cm d.1 m e. 4 cm

24. The centers of two slits of width a are a distance d apart. If the fourth minimum of the interference pattern occurs at the location of the first minimum of the diffraction pattern for light of wavelength λ, the ratio a/d is equal to

a. 0. **b.** $\dfrac{1}{4}$. c. $\dfrac{2}{7}$. d. $\dfrac{1}{3}$. e. $\dfrac{2}{5}$.

Relativity:

25 In the Michelson-Morley experiment, a light beam was divided into two light beams traveling in perpendicular directions. The beams returned along the same paths and recombined. This experiment showed that

a) the speed of light was different along the two different paths

b) the luminiferous ether always traveled with one of the arms of the interferometer

c) light traveled equal distances in perpendicular directions in equal times

d) the sun established an absolute frame of reference for the Earth

e) experiments which fail to yield expected results are fundamentally flawed

26. A meter-stick is shot from a meter-stick projector at a speed of 0.90 c. How long will it be relative to an observer's frame of reference?

a. 2.3 m b. 0.91 m c. 1.0 m **d. 0.44 m** e. 0.81 m

27. The half-life of a muon is 2.2 μs as measured in a stationary reference frame. What is the half life of the muon (in μs) when it is moving with a speed of $v = 0.800\ c$?

a. 8.13 b. 2.75 **c. 3.67** d. 15.8 e. 1.32

28. A proton's rest mass is 1.67×10^{-27} kg. Calculate its total energy when it is accelerated to a speed of 0.80 c.

a. 1.5×10^{-10} J b. 1.0×10^{-10} J **c. 2.5×10^{-10} J**

d. 2.0×10^{-10} J e. 7.5×10^{-10} J

Modern Physics:

29. A stopping potential of 3.2 V is needed for radiation whose wavelength is 200 nm. What is the work function (in eV) of the material?

a. 4.0 **b. 3.0** c. 5.0 d. 6.0 e. 2.0

30. Assume electrons are accelerated through a potential difference of 25,000 V inside a TV picture tube. What is the minimum wavelength that could be produced when the electrons strike the phosphor? (1 Å = 10^{-10} m)

a. 0.5 Å b. 1.0 Å c. 10 Å d. 100 Å e. 0.25 Å

31. A photon whose wavelength is = 5.0×10^{-11} m is scattered straight backward. What is the wavelength of the scattered wave?

a. 5.0×10^{-11} m b. 4.5×10^{-11} m **c. 5.5×10^{-11} m**

d. 6.0×10^{-11} m e. 6.5×10^{-11} m

32. An electron has been accelerated by a potential difference of 100 V. If its position is known to have an uncertainty of 1 nm, what is the percent uncertainty ($\Delta p/p \times 100$) of the electron?

a. 1% **b. 2%** c. 10% d.>>10% e. 5%

REVIEW PROBLEMS:

33 An isolated copper sphere of radius 5cm, initially uncharged, is illuminated by ultraviolet light of wavelength 200nm. What charge will the photoelectric effect induce on the sphere. The work function for copper is 4.70eV.

a. -1.04pC b. 4.06pC c. 7.12pC **d. 8.41pC**
e. none of these answers

34 The space station orbiting distant star (r_{star}= 1mln km, R_{orbit} =400mln km) uses a hemisphere of 40m diameter as an antenna to power its operations. The opto-electrical module converts ALL of the EM energy received by the antenna into the electrical power with 20% efficiency. Find the wavelength for which the unknown star has the maximum in blackbody radiation profile. The station is powered at 20kW.

a. 750nm b 890nm c.1190nm d.1330nm e. None of these answers

35 Guitar player is plucking a string of length 30cm. How fast must the guitar player move towards or away from the stationary observer, in order for the observer to mistake the fundamental frequency for the second harmonic?

a	**$2v_{sound}$ (towards)**
b	v_{sound} (away)
c	$0.5v_{sound}$ (towards)
d	$0.25v_{sound}$ (away)
e	none of these answers