Department of Physics

PCS 125 – Waves and Fields

Please insert in the circle the initial of your last name inside

Please Print Clearly:

Student:_____ _____

Last Name ***First Name***

Student Number: _____ **Student Section:** _____

Final exam – April 25, 2011

Circle the name of your professor:

Dr. Abbas		Dr. Carvalho		Dr. Holder		Dr. Hu		Dr. Yuan	

Read the following attentively

- Duration of the exam: 2 hours and 30 minutes (150 minutes).
- The exam has 13 pages (including the front page and the formula sheet page).
- The exam consists of 23 questions each worth one mark. The maximum exam mark is 23.
- Half of the mark obtained in the first 8 questions, (which cover material included in the mid-term test), will be added to the current test mark. For example if you get a total of 7 marks in these 8 questions, your previous test mark is increased by 3.5. The test mark cannot exceed 30.
- Note that for each multiple choice question:
  - You have to provide, in this booklet, a justification for your answer.
  - The work shown in your exam booklet may be checked. If no work or correct argument is shown to validate your answer, the resulting mark may be zero, even if the answer in the scantron is correct.
  - Transfer your choices to the scantron only when you're sure of them. Some answers may be rounded off.
- All Ryerson exam rules apply.
- Sharing of pens, erasers and calculators is not permitted.
- Talking to another student or glancing over another student's paper is not permitted and may result in a charge of academic misconduct.
- A formula sheet is provided with the test booklet. No other sheets are allowed.
- The only calculators allowed are either the Sharp EL-546 or Casio FX-991. If you are found to have another type of calculator (even if not programmable) it will be confiscated for the duration of the test

_____

Student signature (no signature, no mark!)

1. Astronauts on the first trip to Mars take along a pendulum that has a period on earth of 1.50s. The period on Mars turns out to be 2.45 s. What is the acceleration due to gravity on Mars?

(a) 4.58 m/s^2
(b) 2.87 m/s^2
(c) 2.67 m/s^2
(d) 3.97 m/s^2
(e) 3.67 m/s^2

2. A pendulum with a length of 1.0 m is released from an initial angle of 15.0°. After 1000 s, its amplitude has been reduced by friction to 5.50°. What is the value of $b/2m$?

(a) 0.4×10^{-3} s^{-1}
(b) 1.8×10^{-3} s^{-1}
(c) 1.0×10^{-3} s^{-1}
(d) 2.4×10^{-3} s^{-1}
(e) 2.0×10^{-3} s^{-1}

3. A traveling wave is described by the function:

$$y(x,t) = 0.1 \text{ m} \cos [\ 4.0\ x + 3.0\ t + 3.0\ ]$$

where x and y are in meters and t is in seconds. What is the velocity of this traveling wave?

(a) +1.3 m/s **i** (b) –0.75 m/s **i** (c) –1.3 m/s **i**
(d) +0.75 m/s **i** (e) –3.0 m/s **i**

4. A wave with a frequency of 1200 Hz and a wavelength of 24 cm propagates along a wire that is under a tension of 800 N. What will be the wavelength when the tension is decreased to 600 N and the frequency is kept constant?

(a) 18 cm (b) 32 cm (c) 21 cm (d) 28 cm
(e) None of the above

5. According to Canadian government regulations, the maximum sound intensity level in a workplace is 90.0 dB. In a given factory there are 32 identical machines which altogether produce a sound intensity level of 92.0 dB clearly above the government regulation. How many machines must be shut down to bring the factory into compliance with the regulation?

(a) 2 (b) 8 (c) 12 (d) 16 (e) 20

6. Two ambulances traveling in opposite directions at the same speed approach each other when one of them sounds its siren, which has a frequency of 544 Hz. The driver of the other ambulance hears the frequency as 563 Hz. If the speed of sound in air is 344 m/s, what is the speed of the ambulances?

(a) 10.0 m/s (b) 11.6 m/s (c) 7.24 m/s (d) 8.19 m/s (e) 5.90 m/s

7. A tube in air open at both ends supports standing waves at frequencies of 300 Hz and 400 Hz, and at no frequencies between these two. The second lowest standing wave supported by this tube has frequency

(a) 150 Hz (b) 200 Hz (c) 250 Hz

(d) 50 Hz (e) 100 Hz

8. A standing-wave pattern is observed in a thin wire with a length of 6.00 m and fixed at both ends. The wave function is given by $y = 0.0150 \sin(\pi x/2) \cos(50\pi t)$, where x and y are in meters and t is in seconds.
How many loops does this pattern exhibit?

(a) 2 (b) 4 (c) 5 (d) 3 (e) 1

9. An object is released from rest at a height h above the surface of a planet of mass M and radius $R < h$. With what speed will the object strike the surface of the planet? Disregard any dissipative effects of the atmosphere of the planet.

(a) $\left[\frac{2GMh}{R(R+h)}\right]^{1/2}$

(b) $\left[\frac{2GM}{R}\right]^{1/2}$

(c) $\left[\frac{2GM(h-R)}{Rh}\right]^{1/2}$

(d) $\left[\frac{2GM}{R+h}\right]^{1/2}$

(e) $\left[\frac{2GM}{R+h}\right]^{1/2}$

10. At the moment of a total solar eclipse, the moon lies along a line from the Earth to the sun. If your normal weight is 600 N, how much does your weight change by the combined pull of the sun and moon knowing that the mass of the sun is 2.0×10^{30} kg, the distance from the center of the sun to the center of the earth is 1.5×10^{8} km, the mass of the moon is 7.4×10^{22} kg, and the distance from the center of the moon to the center of earth is 3.8×10^{5} km. The radius of the earth is 6.37×10^{6} m.

(a) decreases by 0.37 N

(b) decreases by 0.07 N

(c) increases by 0.37 N

(d) increases by 0.07 N

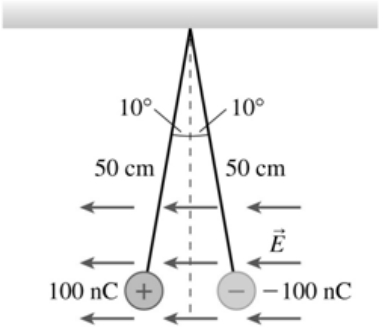
(e) stays the same

11. A system consists of three particles, each of mass 6.00 g, located at the corners of an equilateral triangle with sides of length 16.0 cm. What is the potential energy of the system?

(a) 4.50×10^{-14} J (b) -4.50×10^{-14} J (c) 2.82×10^{-13} J

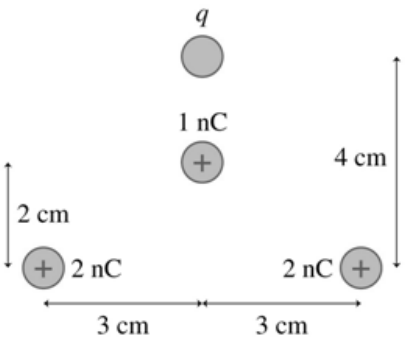
(d) -9.38×10^{-14} J (e) -2.82×10^{-13} J

12. The figure below shows two identical small spheres hanging from threads of negligible mass. One of the spheres has a charge of +100 nC and the other has a charge of –100 nC. They hang in a 10^5 N/C electric field indicated by the horizontal arrows. When equilibrium is reached the threads make an angle of 10^o with the vertical. The mass of each sphere is *m*. What is the value of *m*?



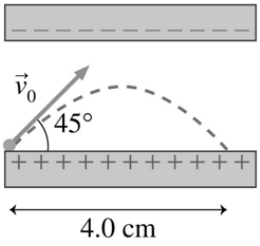
(a) 5.06 g
(b) 2.30 g
(c) 3.04 g
(d) 4.06 g
(e) 7.12 g

13. Observe the distribution of charges shown in the figure. Knowing that the net force on the 1nC charge is zero, determine the charge q located right above the 1 nC charge?



(a) 0.47 nC (b) 0.98 nC (c) 1.68 nC
(d) 2.05 nC (e) 0.68 nC

14. An electron is launched at a 45° angle with a speed of 5.0×10^6 m/s from the positive plate of the parallel plates shown in the figure below. The electron lands 4.0 cm away. Determine the electric field that exists in the space between the plates.



(a) 0.53×10^4 N/C (b) 3.56×10^3 N/C (c) 1.23×10^4 N/C
(d) 5.23×10^2 N/C (e) None of these

15. An electron moving parallel to the x axis has a speed of 5.00×10^5 m/s at $x = 0$ and a speed of 6.00×10^6 m/s at the point $x = 3.00$ cm. Calculate the electric potential difference between the two points, that is, calculate $V_{x=3} - V_{x=0}$.

(a) 102 V (b) –102 V (c) –67.2 V
(d) 204 V (e) –204 V

16. Charge $q_1 = -26.0$ nC is at $x = 0$ and charge $q_2 = 11.5$ nC is at $x = 7.00$ cm. Find the x-coordinate of a point between the charges where the electric potential is zero.

(a) $x = 4.85$ cm (b) $x = 12.6$ cm
(c) $x = 5.55$ cm (d) $x = 2.15$ cm (e) $x = 3.50$ cm

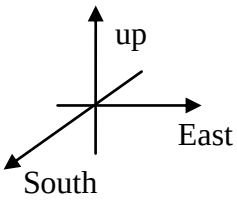
17. A particle with negative charge, $-Q$, is located at the origin of the *xyz* axes. A second particle with positive charge $+q$ is placed at a point P of coordinates (x, y, z).
Complete the following sentence by filling the blanks with one of the options given below.

"If the second particle has charge $-q$ instead of $+q$, then the electric potential at point P due to $-Q$ will _____ and the electric potential energy of the two-particle system will _____."

(a) increase; increase
(b) remain the same; increase
(c) remain the same; decrease
(d) decrease; decrease
(e) decrease; increase

18. An electron traveling due north enters a region that contains both a magnetic field and an electric field. The electric field lines point due west. It is observed that the electron continues to travel in a straight line due north. In which direction must the magnetic field lines point?

(a) South (b) East (c) West (d) down (e) up



19. A velocity selector consists of electric and magnetic fields given by the expressions $\mathbf{E}=E\,\mathbf{k}$ and $\mathbf{B} = 25.0\,\mathbf{j}$ (mT). Find the value of E such that a 700 eV proton moving in the negative x direction travels undeflected.

(a) 244 kV/m

(b) 39.2 kV/m

(c) 6.92 kV/m

(d) 9.15 kV/m

(e) 2.89 kV/m

20. A Hall-effect probe operates with a 140 mA current. When the probe is placed in a uniform magnetic field of magnitude 0.08T, it produces a Hall voltage of 0.6μV. When it is used to measure an unknown magnetic field, the Hall voltage is 0.4 μV. What is the magnitude of the unknown field?

(a) 0.53 mT (b) 53.3 mT (c) 33.3 mT

(d) 0.30 mT (e) 18.8 mT

21. An electron beam is directed across the center of this page, from left to right. What is the direction of the magnetic field caused by the electron beam at the top of the page? (Ignore the effects of the Earth's magnetic field)

(a) Up the page

(b) Down the page

To the left

(c) Into the page

(d) Out of the page

22. Let's model the Earth's magnetic field as resulting from a current loop inside the earth, in the plane of the equator. Specifically, assume the current loop has radius $a = R_E/2$ and its center coincides with the center of the earth. Given that the magnetic field strength on the Earth's surface at the poles is $B(R_E) = 6.0\times10^{-5}$ T, what is the magnetic field strength at the center of the Earth? (R_E is the radius of the Earth and equals 6.3×10^{6} m)

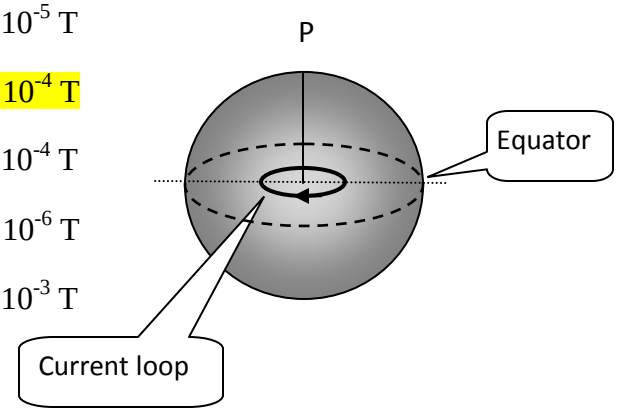
(a) 6.0×10^{-5} T

(b) 6.7×10^{-4} T

(c) 1.2×10^{-4} T

(d) 4.2×10^{-6} T

(e) 4.2×10^{-3} T



23. Three long current-carrying wires are perpendicular to the *xy* plane passing through the points (x,y) = (0, –1 cm), (0, +1 cm) and (+1 cm, 0), respectively.
If each wire carries a current I = 2.0 A in the +*z*-direction, what is the magnetic field at the origin?

(a) $(B_x, B_y, B_z) = (0, 0, 1.2\times10^{-4})$ T

(b) $(B_x, B_y, B_z) = (0, 4.0\times10^{-5}, 0)$ T

(c) $(B_x, B_y, B_z) = (0, -4.0\times10^{-5}, 0)$ T

(d) $(B_x, B_y, B_z) = (-8.0\times10^{-5}, -4.0\times10^{-5}, 0)$ T

(e) $(B_x, B_y, B_z) = (8.0\times10^{-5}, -4.0\times10^{-5}, 0)$ T