Your name sticker with exam code

1. The exam will last from 3:25pm to 4:25pm. Use a #2 pencil to make entries on the answer sheet. Enter the following id information now, before the exam starts.

2. In the section labelled NAME, enter your last name, then fill in the empty circle for a blank, then enter your first name, another blank, and finally your middle initial.

3. Under STUDENT # enter your 9-digit Student ID Number. Under COURSE enter 272. Under CODE enter the exam code given above.

4. During the exam, you may use pencils, a calculator, and ONE $8\frac{1}{2} \times 11$" sheet of paper with formulas and notes.

5. There are 16 multiple-choice questions on the exam. For each question, mark only one answer on the answer sheet. There is no subtraction of points for an incorrect answer, so even if you cannot work out the answer to a question, you should make an educated guess. At the end of the exam, hand in only the answer sheet. Retain this question paper for future reference and study.

6. Useful numerical constants are given on the next page. Before starting the exam, make sure that your copy contains the page of constants and all 16 questions. Bring your exam to the proctor if this is not the case.
Acceleration due to gravity $g = 9.8 \text{ m/s}^2$
Elementary charge $e = 1.6 \times 10^{-19} \text{ C}$
Proton charge $= 1.6 \times 10^{-19} \text{ C}$
Electron charge $= -1.6 \times 10^{-19} \text{ C}$
1 electron volt (eV) = $1.6 \times 10^{-19} \text{ J}$
Proton mass $= 1.673 \times 10^{-27} \text{ kg} = 938.3 \text{ MeV/}c^2$
Electron mass $= 9.11 \times 10^{-31} \text{ kg} = 0.511 \text{ MeV/}c^2$
$1/4\pi\varepsilon_0 = 9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$
$\mu_0 = 4\pi \times 10^{-7} \text{ T} \cdot \text{m/A}$

Powers of ten:

<table>
<thead>
<tr>
<th>femto (f)</th>
<th>pico (p)</th>
<th>nano (n)</th>
<th>micro (µ)</th>
<th>milli (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^{-15}$</td>
<td>$10^{-12}$</td>
<td>$10^{-9}$</td>
<td>$10^{-6}$</td>
<td>$10^{-3}$</td>
</tr>
<tr>
<td>centi (c)</td>
<td>kilo (k)</td>
<td>Mega (M)</td>
<td>Giga (G)</td>
<td>Tera (T)</td>
</tr>
<tr>
<td>$10^{-2}$</td>
<td>$10^3$</td>
<td>$10^6$</td>
<td>$10^9$</td>
<td>$10^{12}$</td>
</tr>
</tbody>
</table>
1. If the density of the atmosphere were constant at 1.29 $kg/m^3$, what would be its height? On the ground, atmospheric pressure is $1.01 \times 10^5 \, Pa$.
   
   a) About 1000 m
   
   b) About 2000 m
   
   c) About 3000 m
   
   d) About 4000 m
   
   e) About 8000 m

2. An ice cube (density = 920 $kg/m^3$) is pushed to the bottom of a glass of water (density = 1000 $kg/m^3$) and then released. Neglecting frictional effects, with what acceleration will the ice cube start to rise?
   
   a) 0.920g
   
   b) 0.479g
   
   c) 0.087g
   
   d) 1.090g
   
   e) 0.080g

3. A rock weighs 50 $N$ in air. If it is submerged in water, it weighs 30 $N$. What is its volume? (Density of water = 1000 $kg/m^3$).
   
   a) About 0.003 $m^3$
   
   b) About 0.008 $m^3$
   
   c) About 0.006 $m^3$
   
   d) About 0.002 $m^3$
   
   e) About 0.005 $m^3$

4. An open U-tube is partially filled with water (density = 1000 $kg/m^3$). Oil, of density 750 $kg/m^3$, is poured into the right arm until the water level in the left arm rises 3 cm. What then is the height of the oil column?
   
   a) 8 cm
   
   b) 6 cm
   
   c) 4 cm
   
   d) 3 cm
   
   e) None of the other answers
5. See the figure for this question. A block of wood of mass 4 kg and density 400 kg/m$^3$ is held under water (density = 1000 kg/m$^3$) by a string attached to the bottom of the tank. What is the tension in the string?
   a) About 39 N  
   b) About 59 N  
   c) About 98 N  
   d) About 112 N  
   e) About 137 N

6. One of the resonant frequencies on a string of length 0.6 m is 480 Hz. The next higher resonant frequency is 560 Hz. What is the wave speed?
   a) 96 m/s  
   b) 288 m/s  
   c) 336 m/s  
   d) 576 m/s  
   e) 192 m/s

7. A certain guitar string is resonant at 1320 Hz. If the string tension is increased by 2%, what will be the new resonant frequency for the same harmonic?
   a) 1294 Hz  
   b) 1307 Hz  
   c) 1320 Hz  
   d) 1333 Hz  
   e) 1346 Hz

8. A singer is singing a song. Which of the following changes will allow the speed of the sound waves to increase?
   - I: Singing more loudly
   - II: Singing less loudly
   - III: Increasing the frequency of the sound

   a) I only  
   b) II only  
   c) III only  
   d) I and III, but not II  
   e) None of these will increase the wave speed
9. An organ pipe is open at both ends. For the second harmonic \((n = 2)\), how many standing wave nodes are there in the pipe?
   a) Zero
   b) 4
   c) 2
   d) 1
   e) 3

10. A vacuum cleaner has a sound level of 70 dB. How many such vacuum cleaners would produce a sound level equal to that of busy traffic, which is about 83 dB?
   a) 1.2
   b) 20
   c) 13
   d) 15
   e) 11

11. A moth is flying at 3 m/s. It is being chased by a bat flying at 11 m/s (in the same direction as the moth). The bat emits a sound of frequency 50.0 kHz. If this sound reflects off the moth and returns to the bat, what frequency does the bat hear? Speed of sound = 343 m/s.
   a) About 51.2 kHz
   b) About 54.3 kHz
   c) About 52.4 kHz
   d) About 50.9 kHz
   e) About 53.3 kHz

12. The electrical force between two charged objects is \(F\). If the charge on EACH object is DOUBLED, and their separation is HALVED, what is then the magnitude of the electrical force between them?
   a) \(F\)
   b) \(2F\)
   c) \(4F\)
   d) \(8F\)
   e) \(16F\)
13. See the figure for this question. A charge of +2.0 \( \mu C \) is on the x-axis at \( x = +3 \text{ cm} \), while a charge of −3.0 \( \mu C \) is on the y-axis at \( y = +3 \text{ cm} \). What is the magnitude of the force on a third charge of −1.0 \( \mu C \) placed at the origin?
   a) About 10 \( N \)
   b) About 20 \( N \)
   c) About 30 \( N \)
   d) About 36 \( N \)
   e) About 50 \( N \)

14. See the figure for this question. A charge of +2 \( \mu C \) is on the x-axis at \( x = +20 \text{ cm} \). An unknown charge \( Q \) is on the x-axis at \( x = −40 \text{ cm} \). If the electric field is zero at \( x = +40 \text{ cm} \), what is the value of \( Q \)?
   a) +8 \( \mu C \)
   b) −2 \( \mu C \)
   c) −8 \( \mu C \)
   d) +32 \( \mu C \)
   e) −32 \( \mu C \)

15. A charge of +4 \( nC \) is located at the point (20 \( \text{ cm} \), 15 \( \text{ cm} \)), and another charge of +4 \( nC \) is located at (20 \( \text{ cm} \), −15 \( \text{ cm} \)). What is the magnitude of the electric field at the origin?
   a) Zero
   b) About 922 \( N/C \)
   c) About 1152 \( N/C \)
   d) About 1800 \( N/C \)
   e) About 691 \( N/C \)

16. A rod of length \( L \) has total charge \( +Q \) distributed uniformly. It is placed on the x-axis so that it extends from the origin to \( x = L \). The electric field at any point \( x > L \) is \( 1/4\pi\epsilon_0 \) times
   a) \( Q/[x(x - L)] \)
   b) \( Q/(x - L/2)^2 \)
   c) \( Q/[x(x - L/2)] \)
   d) \( Q/(x - L)^2 \)
   e) None of the other answers