

Econ (2 pts each) (20 pts)

1. **2.5** Price Elasticity of Demand = $[(2,000,000-12,000,000)/(2,000,000+12,000,000)] / [(9-5)/(5+9)] = [-10/14]/[4/14] = -2.5$ (accept -2.5 or 2.5, where negative sign is assumed)
2. **P = \$9, Q = 2 million** Since the equilibrium price is \$7 (because at that price an equal quantity is supplied and demanded), the price floor will be set at \$9. Since there is only a demand of 2 at \$9, 2 million pizzas will be sold.
3. **\$20 million**
4. Because the two externalities affect the quantity in opposing directions, it is **ambiguous/impossible to determine** how the socially optimal quantity relates to the quantity achieved by the private market
5. **Country B**
6. **AD = C + I + G + NX** (Aggregate Demand = consumption + investment + government purchases + net exports) (Note: accept exports - imports for net exports)
7. **\$3 million** Since 10% of the \$20 million in deposits must be reserves, which is \$2 million, the excess reserves are the additional reserves the bank holds. (\$5 million - \$2 million)
8. **Government purchases increase**
9. **Consumption increases, but Ford's investment decreases** (by an equivalent amount) since Ford's inventory has decreased
10. **No change- Government investment remains the same** because unemployment benefits are a transfer payment, which is not included in government purchases

Physics (Questions 1 2 and 3 are 1 pt. Questions 4,5, and 6 are 3 pts) (12pts)

- 1) $\text{Sqrt}[442/4.9] = 9.50 \text{ s}$
- 2) $\text{Sqrt}[2] (1.41)$
- 3) Wave speed is defined as $v=w/k$. So the wave speeds are a - $1/3$, b - 2, c - 4, d - $1/2$. The correct ordering is c-b-d-a.
- 4) a - $2 \text{ pi rad}/60 \text{ s} = \text{pi}/30 \sim 0.105 \text{ /s}$. b - $2 \text{ pi rad}/ 3600 \text{ s} = \text{pi}/1800 \sim .00175 \text{ /s}$. c - $2 \text{ pi rad}/ 43200 \text{ s} = \text{pi}/ 21600 \sim .000145 \text{ /s}$.
- 5) Using conservation of momentum and noting that the initial system has zero momentum, we calculate the final speed of the first sled (that the goat jumped off) to be -4.00 m/s (that is, **4.00 m/s** in the opposite direction of the goat's jump). The final speed of the other sled is **20/9 m/s, or 2.22 m/s, in the direction of the goat's jump.**
- 6) Conservation of Energy: Height of the ramp is $10 \text{ Cos}(30 \text{ degrees}) = 5\text{m}$, so potential energy is $2500 * (9.8) \text{ J}$. Kinetic energy at the bottom is $250v^2$ so velocity is given by **9.90 (or about 10) m/s**

[Questions 3,4,5 based off of Ward Lopes Phys 141 quiz, Fall 2010]

Math (Questions 1, 2, and 3 are 2 pts. The rest are 3 pts) (18pts)

1) $f'(0) = (17 \cos(17x) - 4e^x)(97x^2 + 155) + (\sin(17x) - 4e^x)(194x) = (13)(155) = 2015$

2a) $\frac{1}{3}$

2b) The new probability is $\frac{2}{3}$. You should always change your choice.

3) After n folds, the thickness of the paper is $0.1 * 2^n$ mm. Thus we want to solve for M , where $0.1 * 2^M = 4.0 * 10^{11}$, all in mm. We take logs to find $M=41.863$, so **the correct answer is 42**.

4) Since the diameter is increasing by 2 cm each second, the radius of the bubble is increasing by 1 cm/s. Thus $r[t] = t + 1$. The amount of air being blown into the bubble is just the change in volume, and we see $dV/dt = 4 \pi r^2 dr/dt = 4 \pi r^2$. After 4 seconds, the radius of the bubble is $r(4) = 5$ cm, so $dV/dt = 4 \pi (25) = \mathbf{100 \pi \text{ cm}^3 / \text{s}}$. Go Rocketlauncher Steve!

5) Let x be the length of barn used, and y be the length of the other side of the fence used. Then the cost is $C = 20 + 1.2x + 2y$. Area = $x*y$. We have $y = 240 - .6x$. So Area = $-.6x^2 + 240x$. To find the maximum. We take the derivative $dA/dx = 0 = -1.2x + 240$, and find $x = 200$. Therefore $y = 120$, so Area = $xy = \mathbf{24000 \text{ square feet}}$.

6) According to the Fundamental Theorem of Calculus, the average velocity equals

$$\frac{1}{b-a} \int_a^b v_i + at = 0.5 [0t + 0.5at^2]_0^4 = 0.5 [0.5(-9.8)(4)] = \mathbf{-9.8 \text{ meters per second}}$$
 (accept 9.8)

7) Announce to all the current guests: if you are in room n , move to room $2n$. You will then have opened up infinitely many rooms (the odd ones) which you can use for the new guests. (Alternatively, you can replace 2 with any integer m . There are lots of ways to do this, and I don't mind checking these. - Joe)

Biology (Question 1 is 3 pts, The rest are 1 pt) (17pts)

1.

- a. Griffith: non-virulent ("rough") bacteria → mouse lives, virulent bacteria (smooth) → mouse dies, killed virulent → mouse lives, killed virulent + live non-virulent → mouse dies. This implies that there is some transforming factor.
 - b. Avery et al. Took infected cells, lysed them, fractionated them, and added protease, RNAse, and DNAse. First two had no effect on transformation, while DNAse stops the transformation, indicated that DNA is the transforming factor.
 - c. Hershey-Chase: tagged viral protein and DNA separately (protein with sulphur and DNA with phosphorus). They then infected bacteria with the bacteriophage ran the bacteria through a blender and analyzed the result → phosphorus. Indicated that DNA is the genetic material.
2. Helicase unwinds the DNA and exposes each strand for replication. DNA polymerase adds new nucleotides to the nascent DNA. Topoisomerase prevents supercoiling (unnatural coiling) of DNA as it's being formed.
 3. Transcription is the synthesis of RNA from a DNA template where the code in the DNA is converted into a complementary RNA code. Translation is the synthesis of a protein

from an mRNA template where the code in the mRNA is converted into an amino acid sequence in a protein.

4. Semiconservative means that each new double stranded DNA molecule has one parent strand in it and one duplicated strand.
5. Primary structure is the order of the amino acids; secondary structure is their configuration into either alpha helices or beta sheets; tertiary structure is their organization into having multiple secondary structures, becoming a functional subunit; some proteins (not all) have quaternary structures with several interacting subunits.
6. Rough Endoplasmic Reticulum
7. Smooth Endoplasmic Reticulum
8. Nucleus
9. Ribosome
10. Golgi apparatus
11. Plasma Membrane
12. Mitochondrion
13. Centriole
14. Lysosome
15. Animal cell. Plant cells would have a rigid cell wall and a vacuole in the center (also accept have chloroplasts)

Chemistry (Questions 1 - 6 are 1 pt, Questions 7-9 are 2 pts) (12pts)

1. 2.5 mL
2. Sodium peroxide
3. Ammonium bicarbonate
4. Disulfur dichloride
5. Nitrous acid
6. Pentagonal Bipyramidal
7. $196 \text{ J/mol}\cdot\text{K}$
8. 513.29 kJ/mol
9. 2916.84 K ($2643.83 \text{ }^\circ\text{C}$)

Music Theory: (2pt each) (14pts)

1. a minor
2. Authentic Cadence (Imperfect Authentic Cadence)
3. E Major or V chord. It is a dominant function.
4. B Major 6-5 or IV₅⁶ This chord is Predominant
5. Picardy Third
6. Descending Second Sequence (Circle of Fifths)
7. Perfect 4th

Psych (2pt each) (18pts)

1. Dopamine
2. Object Permanency
3. Motor Cortex
4. Defense Mechanisms
5. Placebo Effect
6. Flashbulb Memory
7. Phineas Gage
8. Positive and Negative
9. Stanley Milgram; obedience

Art History: (.5 pt per part) (15 pts)

1.
 - a. Dome on the Rock
 - b. Jerusalem
 - c. Early Medieval (692AD)
2.
 - a. Hagia Sophia
 - b. Constantinople (Istanbul)
 - c. Early Medieval (532-537 AD)
3.
 - a. Abbey Church of St. Denis (Basilica of St. Denis)
 - b. Paris
 - c. French Early Gothic
4.
 - a. Arch of Titus
 - b. Rome
 - c. Roman
5.
 - a. Baptistery of Pisa
 - b. Pisa
 - c. Romanesque
- 6.

- a. Florence Cathedral (Dome)
 - b. Filippo Brunelleschi
 - c. Renaissance
7.
 - a. Music at the Tuileries
 - b. Edouard Manet
 - c. Realism (3rd Quarter 19th Century)
8.
 - a. Primavera
 - b. Sandro Botticelli
 - c. Renaissance
9.
 - a. Ghent Altarpiece (Adoration of the Mystic Lamb)
 - b. Jan (and Hubert) van Eyck
 - c. Early Netherlandish
10.
 - a. The Milkmaid/ The Kitchen Maid
 - b. Johannes Vermeer
 - c. Baroque

Languages: (1pt each) (20 pts)

1. Spanish
2. Russian
3. Turkish
4. Chinese
5. Korean
6. Italian
7. Greek
8. Dutch
9. Serbian
10. French
11. German
12. Bengali
13. Bosnian
14. Portuguese
15. Hebrew
16. Hindi
17. Croatian
18. Nepali
19. Swedish
20. "Hello. My name is Polar Vortex. I am two years old and go to Williams College.
What's your name?"

Total: 146 points