

**Ryan Cohen**  
**PHYSICS ROUND**

**TOSS-UP**

1) PHYSICS *Short Answer* Using either numbers or words, denote which of the following frames of reference are inertial according to Newtonian mechanics, if frame of reference A is inertial.

- 1: A frame of reference accelerating relative to frame of reference A
- 2: A frame of reference moving with constant velocity relative to frame of reference A
- 3: A frame of reference at rest relative to frame of reference A
- 4: A frame of reference in which Newton's first law is valid

ANSWER: 2, 3, and 4

**BONUS**

1) PHYSICS *Short Answer* If an object at sea level has a mass of 12kg and is pulled upwards with a force of 26N, what is the magnitude of the normal force in newtons exerted on the object, rounded to the tens place?

ANSWER: 90

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**TOSS-UP**

2) PHYSICS *Multiple Choice* Used in refrigerator magnets and brushless AC motors, which of the following is an arrangement of permanent magnets that augments the magnetic field on one side, while cancelling the field to near zero on the other side:

- W) Halbach Array
- X) Tesla Configuration
- Y) Meissner Array
- Z) Weber Configuration

ANSWER: W) HALBACH ARRAY

**BONUS**

2) PHYSICS *Short Answer* What property allows live frogs to be levitated in strong magnetic fields and causes bismuth to be repelled by magnetic fields?

ANSWER: DIAMAGNETISM

### TOSS-UP

3) PHYSICS *Short Answer* If the function  $s(t)$  represents position with respect to time, what physical quantity is defined by the function  $s'''(t)$ ?

ANSWER: JERK

### BONUS

3) PHYSICS *Multiple Choice* Which of the following equations does not correctly define jerk, assuming yank is equal to the change in force over change in time:

W) jerk = change in acceleration/time

X) jerk = yank/mass

Y) jerk = average velocity/time squared

Z) jerk = change in force/mass times time

ANSWER: Y) JERK = AVERAGE VELOCITY/TIME SQUARED

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### TOSS-UP

4) PHYSICS *Short Answer* In what thermodynamic process is heat added to the system equal to work done by the system?

ANSWER: ISOTHERMAL (PROCESS)

### BONUS

4) PHYSICS *Short Answer* What is the work done in joules by a system with a pressure of 10 pascals that goes through an isobaric process, with an initial volume of  $3\text{m}^3$  and a final volume of  $10\text{m}^3$ ?

ANSWER: 70

### TOSS-UP

5) PHYSICS *Multiple Choice* Which of the following parts of a simple DC motor most directly produces the torque:

- W) brushes
- X) rotor
- Y) commutator
- Z) motor casing

ANSWER: X) ROTOR

### BONUS

5) PHYSICS *Short Answer* What is the equivalent resistance, in ohms, of a 5 ohm resistor connected in series with a group of two resistors, with resistances of 4 and 6 ohms, connected in parallel?

ANSWER: 7.4

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### TOSS-UP

6) PHYSICS *Short Answer* The north pole of Earth's magnetic field is located in which hemisphere?

ANSWER: SOUTHERN (HEMISPHERE)

### BONUS

6) PHYSICS *Short Answer* Using numbers or words, name all of the following four choices that affect the magnitude of the force on a charged particle moving through a magnetic field:

- 1: Magnitude of charge
- 2: Magnitude of the magnetic field
- 3: Speed of particle
- 4: Direction of movement of particle

ANSWER: 1, 2, 3, and 4 (ACCEPT: ALL OF THEM)

### TOSS-UP

7) PHYSICS *Multiple Choice* Light is unique from other waves, such as sound or water waves in that it:

- W) Has a much longer wavelength
- X) Has a much lower frequency
- Y) Changes direction on extremely frequent intervals
- Z) Does not require a medium to travel through

ANSWER: Z) DOES NOT REQUIRE A MEDIUM TO TRAVEL THROUGH

### BONUS

7) PHYSICS *Short Answer* How many joules of energy, in terms of Planck's constant  $h$  and the speed of light  $c$ , are in a wave with a wavelength of  $10\text{m}$ ?

ANSWER:  $hc/10$

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### TOSS-UP

8) PHYSICS *Short Answer* What is created when light emitted from a neon sign is analyzed with a spectrometer?

ANSWER: EMISSION SPECTRUM

### BONUS

8) PHYSICS *Short Answer* What is the range of wavelengths of visible light, in nanometers?

ANSWER: 400 TO 700

### TOSS-UP

9) PHYSICS *Multiple Choice* An isochoric process could be represented on a pressure-volume diagram by which of the following:

- W) a vertical line
- X) a horizontal line
- Y) a positive curve
- Z) a negative curve

ANSWER: W) A VERTICAL LINE

### BONUS

9) PHYSICS *Multiple Choice* In the Van der Waals Equation of State, the constants a and b are used to compensate for which of the following:

- W) intermolecular forces and entropy
- X) intermolecular forces and size of molecules
- Y) density and size of molecules
- Z) entropy and size of molecule

ANSWER: X) INTERMOLECULAR FORCES AND SIZE OF MOLECULES

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### TOSS-UP

10) PHYSICS *Multiple Choice* Which of the following increases the resistance of an insulated wire:

- W) increasing the diameter of the wire
- X) shortening the wire
- Y) coiling the wire
- Z) heating the wire

ANSWER: Z) HEATING THE WIRE

### BONUS

10) PHYSICS *Short Answer* If electricity costs 1 cent per kilowatt hour, how much does it cost to run a 10 amp toaster on 120 volts for 120 minutes

ANSWER: 2.4 cents

### TOSS-UP

11) PHYSICS *Multiple Choice* In order to determine the force of a compressed spring on an object, it is necessary to know which of the following:

- W) displacement of spring and mass of object
- X) material of spring and displacement
- Y) mass of object and spring constant
- Z) displacement of spring and spring constant

ANSWER: Z) DISPLACEMENT OF SPRING AND SPRING CONSTANT

### BONUS

11) PHYSICS *Short Answer* What is the name of the quantity that describes the ratio of the force on an object to the cross-sectional area?

ANSWER: TENSILE STRESS

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### TOSS-UP

12) PHYSICS *Multiple Choice* When a fluid is at rest in a container, which of the following must be true:

- W) all points are at the same pressure
- X) the fluid has a uniform density
- Y) all points at the same depth are at the same pressure
- Z) the fluid does not exert any force on the container

ANSWER: Y) ALL POINTS AT THE SAME DEPTH ARE AT THE SAME PRESSURE

### BONUS

12) PHYSICS *Short Answer* When considering a volume of fluid,  $V$ , in a container of fluid in static equilibrium, the magnitude of the force exerted by the fluid below  $V$  must be equal to the sum of the force of the fluid above  $V$  and the force of:

ANSWER: GRAVITY

### TOSS-UP

13) PHYSICS *Short Answer* If a rope is given a firm shake, what type of wave travels along its length?

ANSWER: TRANSVERSE (WAVE)

### BONUS

13) PHYSICS *Short Answer* What is the period of a mechanical wave, in seconds, with a frequency of 8 hertz and an amplitude of 15 centimeters?

ANSWER: 1/8 (ACCEPT: 0.125)

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### TOSS-UP

14) PHYSICS *Multiple Choice* Coulomb's Law gives which of the following:

- W) the force between two charged bodies
- X) the net charge in a DC circuit
- Y) the electric potential energy between two points in a DC circuit
- Z) electric potential between the two electrodes of a battery

ANSWER: W) THE FORCE BETWEEN TWO CHARGED BODIES

### BONUS

14) PHYSICS *Short Answer* What causes electrons in a an object to move to one side of the object when an electrically charged body is brought near?

ANSWER: (ELECTROSTATIC) INDUCTION

### TOSS-UP

15) PHYSICS *Multiple Choice* Which of the following is untrue regarding the physical quantity impulse:

- W) impulse is equal to force times a time interval
- X) impulse can be measured in kilogram meters per second
- Y) impulse is equal to change in momentum
- Z) impulse is the derivative of force, with respect to time

ANSWER: Z) IMPULSE IS THE DERIVATIVE OF FORCE, WITH RESPECT TO TIME

### BONUS

15) PHYSICS *Short Answer* What type of collision occurs when two objects collide and stick together?

ANSWER: PERFECTLY INELASTIC

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### TOSS-UP

16) PHYSICS *Multiple Choice* A real gas behaves most closely to an ideal gas in which of the following conditions:

- W) high temperature and high pressure
- X) high temperature and low pressure
- Y) low temperature and high pressure
- Z) low temperature and low pressure

ANSWER: X) HIGH TEMPERATURE AND LOW PRESSURE

### BONUS

16) PHYSICS *Short Answer* What is the volume in meters cubed, in terms of the universal gas constant  $R$ , of 2 moles of an ideal gas at a temperature of 100 kelvin and at a pressure of 1000 pascals?

ANSWER: ' $R/5$ ' OR ' $(1/5)R$ '



### TOSS-UP

17) PHYSICS *Short Answer* A gear train is a compound machine consisting mainly of what type of simple machine?

ANSWER: WHEEL AND AXLE

### BONUS

17) PHYSICS *Short Answer* A lever with an efficiency of 50% is 6cm long on one side of the fulcrum and 4cm long on the other. If a force of 10N is applied on the longer side, what force is applied by the shorter side, in newtons?

ANSWER: '15/2' OR '7.5'

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### TOSS-UP

18) PHYSICS *Multiple Choice* A force 1 newton greater than the theoretical force of kinetic friction is applied to an object on a table. Using words or numbers, name which of the following statements MUST be true:

- 1: The object is moving
- 2: The object is at rest
- 3: The object is accelerating
- 4: The object is decelerating

ANSWER: NONE OF THEM

### BONUS

18) PHYSICS *Short Answer* As you apply a steadily increasing force on an object on a table, the object begins to move when you are applying 10 newtons. If the object's mass is 6kg, what is the coefficient of static friction? Assume  $g$  is equal to 10 meters per second squared.

ANSWER: 1/6

### TOSS-UP

19) PHYSICS *Short Answer* What type of motion is demonstrated by a toy gyroscope that creates a steady circular motion of the axis in a horizontal plane, combined with the spin motion of the flywheel about the axis?

ANSWER: PRECESSION

### BONUS

19) PHYSICS *Multiple Choice* Which of the following most clearly demonstrates precession:

- W) the Earth
- X) a freely spinning motor
- Y) a revolving door
- Z) spiral galaxies

ANSWER: W) THE EARTH

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### TOSS-UP

20) PHYSICS *Short Answer* Mirrors and other smooth surfaces create what type of reflection?

ANSWER: SPECULAR (REFLECTION)

### BONUS

20) PHYSICS *Short Answer* Who is most commonly credited with the discovery of the law of refraction?

ANSWER: (WILLEBRORD) SNELL

### TOSS-UP

21) PHYSICS *Multiple Choice* Which of the following is not a true application of electron tunneling:

- W) specialized diodes
- X) nanoparticle creation
- Y) scanning microscopes
- Z) enzyme function

ANSWER: X) NANOPARTICLE CREATION

### BONUS

21) PHYSICS *Short Answer* Ernest Rutherford's experiments to discover the atomic nucleus depended on the tunneling of what particle?

ANSWER: ALPHA PARTICLE

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### TOSS-UP

22) PHYSICS *Short Answer* A particle has a constant acceleration of  $2 \text{ m/s}^2$ . If it starts from rest, what is the particle's speed after 2 hours?

ANSWER: 14,400 m/s

### BONUS

22) PHYSICS *Multiple Choice* Which of the following could never be true for an object with a nonzero, constant acceleration:

- W) the object has a constant speed
- X) the object is slowing down
- Y) the object stays at rest
- Z) the object is speeding up

ANSWER: Y) THE OBJECT STAYS AT REST

### TOSS-UP

23) PHYSICS *Multiple Choice* Which of the following is not true, regarding the Carnot cycle:

W) the efficiency of the Carnot cycle increases as the gap between the operating temperatures decreases

X) no engine can ever be more efficient than a Carnot engine operating between the same two temperatures

Y) the Carnot cycle is reversible

Z) all Carnot engines operating between the same two temperatures have the same efficiency

ANSWER: W) THE EFFICIENCY OF THE CARNOT CYCLE INCREASES AS THE GAP BETWEEN THE OPERATING TEMPERATURES DECREASES

### BONUS

23) PHYSICS *Short Answer* What is the efficiency of a Carnot cycle operating between heat reservoirs with temperatures of 1000K and 200K?

ANSWER: 0.8

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### TOSS-UP

24) PHYSICS *Short Answer* What law states that the direction of any magnetic induction effect is such as to oppose the cause of the effect?

ANSWER: LENZ'S LAW

### BONUS

24) PHYSICS *Short Answer* A current-carrying wire is oriented vertically, so that electrons flow upwards through the wire. What is the direction of the magnetic field around the wire?

ANSWER: CLOCKWISE

### TOSS-UP

25) PHYSICS *Short Answer* Rank the following four forces in order of increasing force: strong, weak, electromagnetic, gravitational.

ANSWER: GRAVITATIONAL, WEAK, ELECTROMAGNETIC, STRONG

### BONUS

25) PHYSICS *Short Answer* Give the mediating particle and its spin for the strong force, electromagnetic force, and gravitational force.

ANSWER: gluon, 1; photon, 1; graviton, 2