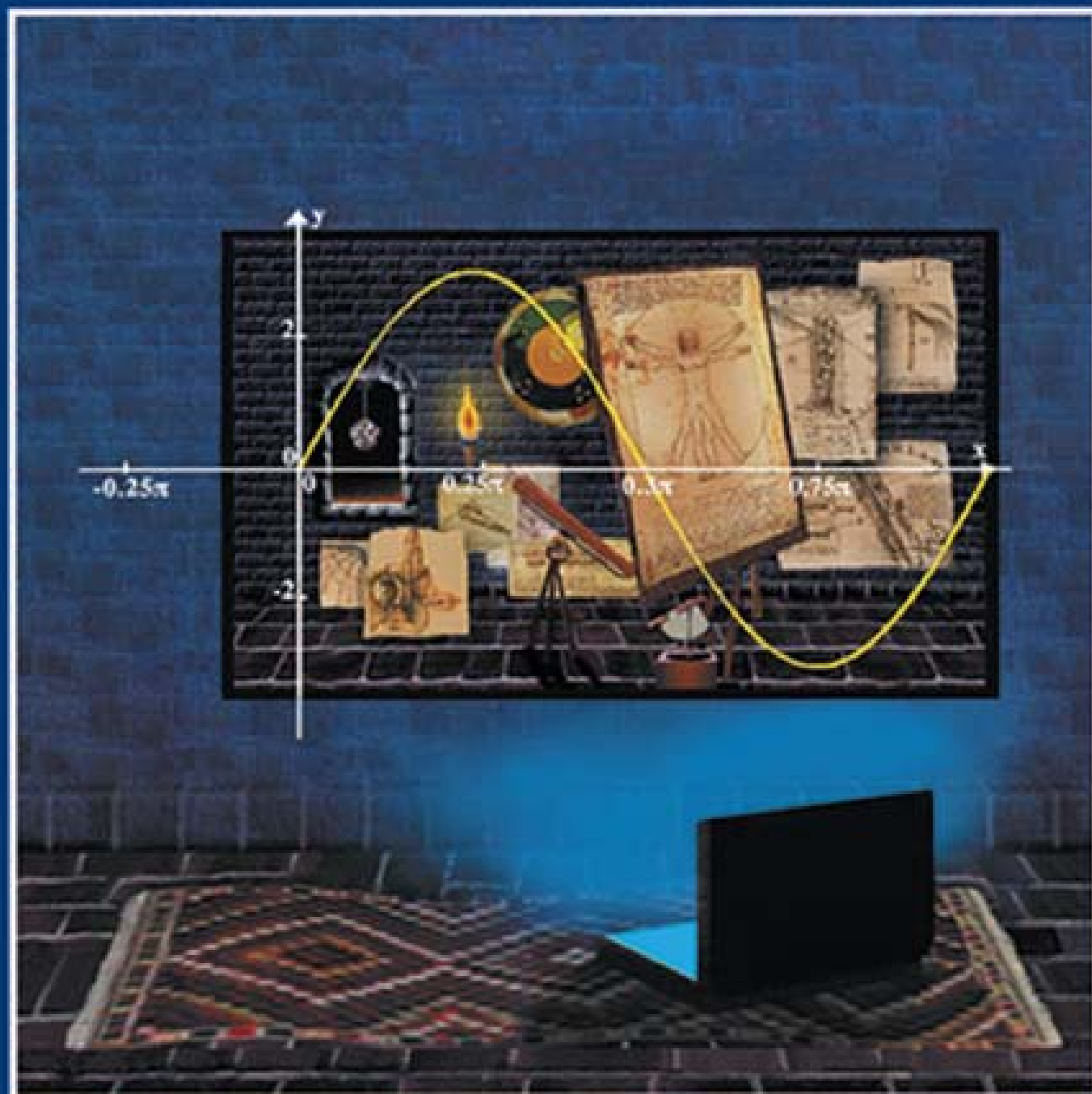


AP PHYSICS B & C



QUESTION CATALOGUE

AP Physics B/C

Question Catalogue Contents

I. NEWTONIAN MECHANICS

A. Kinematics

| | |
|---|----------|
| 1. One-Dimensional Motion | |
| a. Graphs of motion | 1 |
| b. Questions without graphs | 4 |
| c. One-Dimensional motion with calculus [C] | 7 |
| 2. Two-Dimensional Motion | |
| a. Projectile motion | 9 |
| b. Other 2d questions | 13 |
| c. Two-Dimensional motion with calculus [C] | 14 |
| 3. Part Two Questions | |
| a. Free Response Questions | 15 |
| b. Free Response Questions [C] | 17 |

B. Newton's Laws

| | |
|--|----|
| 1. Static Equilibrium (First Law) | |
| a. Tension in a string | 18 |
| b. Inclined planes | 20 |
| c. Other statics problems | 21 |
| 2. Dynamics (Second Law) | |
| a. One - dimensional dynamics | 22 |
| b. Dynamics on an inclined plane | 24 |
| c. Other dynamics problems | 26 |
| 3. Multiple Body Systems (Third Law) | |
| a. Action-reaction pairs | 29 |
| 4. Friction | |
| a. Static friction | 31 |
| b. Kinetic friction | 33 |
| 5. Part Two Questions | |
| a. Free Response Questions | 35 |
| b. Free Response Questions [C] | 42 |

C. Work, Energy, and Power

| | |
|--|----|
| 1. Work and Kinetic Energy | |
| a. $W = F \cdot d$ | 44 |
| b. Work-energy theorem | 46 |
| c. Work and energy with calculus [C] | 32 |
| 2. Potential Energy | |
| a. Gravitational | 50 |
| b. Stored in a spring | 51 |
| 3. Conservation of Energy | |
| a. Kinetic and potential energy | 52 |
| b. Work done against friction | 55 |
| 4. Power | |
| a. $P = W/t$ | 56 |
| b. $P = F \cdot v$ | 57 |
| c. Power with calculus [C] | 58 |

| | |
|---|-----|
| 5. Part Two Questions | |
| a. Free Response Questions | 59 |
| b. Free Response Questions [C] | 62 |
| D. Linear Momentum | |
| 1. Impulse | |
| a. $J = Ft$ | 63 |
| b. Impulse equals change in momentum | 64 |
| 2. One-Dimension | |
| a. Elastic collisions | 66 |
| b. Inelastic collisions | 67 |
| 3. Two-Dimensions | |
| a. Elastic collisions | 70 |
| b. Inelastic collisions | 71 |
| 4. Free Response Questions | |
| a. Free Response Questions | 72 |
| b. Free Response Questions [C] | 76 |
| 5. Center Of Mass [C] | |
| a. Center of mass | 77 |
| E. Circular Motion and Rotations | |
| 1. Uniform Circular Motion | |
| a. Centripetal acceleration | 79 |
| b. Centripetal forces | 81 |
| c. Tangential quantities | 83 |
| 2. Rotational Statics | |
| a. Torque | 85 |
| 3. Rotational Kinematics and Dynamics [C] | |
| a. Rotational motion | 90 |
| c. Work, energy and power | 92 |
| 4. Angular Momentum and its Conservation [C] | |
| a. Angular momentum | 94 |
| b. Conservation of angular momentum | 96 |
| 5. Free Response Questions | |
| a. Free Response Questions | 98 |
| b. Free Response Questions [C] | 101 |
| F. Oscillations and Gravitation | |
| 1. Period of a Simple Harmonic Oscillator | |
| a. Mass on a spring | 104 |
| b. Pendulum | 106 |
| 2. Forces and Energies | |
| a. Spring constant | 108 |
| b. Mass on a spring | 109 |
| c. Pendulum | 112 |
| d. Instantaneous Velocity & Acceleration in SHM [C] | 113 |
| 3. Gravitation | |
| a. Gravitational force | 114 |
| b. Circular orbits | 117 |
| c. Circular orbits [C] | 119 |
| 4. Free Response Questions | |
| a. Free Response Questions | 120 |
| b. Free Response Questions [C] | 123 |

II. FLUID MECHANICS AND THERMAL PHYSICS [B]

A. Fluid Mechanics

| | |
|-------------------------------------|-----|
| 1. Hydrostatic Pressure | |
| a. Hydrostatic Pressure | 125 |
| 2. Buoyancy | |
| a. Magnitude of buoyant force | 127 |
| 3. Fluid Flow Continuity | |
| a. Change in velocity | 130 |
| 4. Free Response Questions | |
| a. Free Response Questions | 133 |

B. Temperature and Heat

| | |
|--|-----|
| 1. Mechanical Equivalent of Heat | |
| a. Conversions | 136 |
| 2. Specific and Latent Heat | |
| a. Specific heat capacity | 138 |
| b. Latent heat of transformation | 140 |
| 3. Thermal Expansion | |
| a. Thermal expansion | 142 |
| 4. Free Response Questions | |
| a. Free Response Questions | 144 |

C. Thermodynamics

| | |
|----------------------------------|-----|
| 1. Ideal Gases | |
| a. Ideal gas law | 146 |
| b. Kinetic theory | 148 |
| 2. First Law of Thermodynamics | |
| a. With pV diagrams | 150 |
| b. No diagrams | 152 |
| 3. Second Law of Thermodynamics | |
| a. Entropy | 154 |
| b. Heat engines | 155 |
| c. Carnot cycles | 157 |
| 4. Free Response Questions | |
| a. Free Response Questions | 158 |

III. ELECTRICITY & MAGNETISM

A. Electrostatics

| | |
|---|-----|
| 1. Coulomb's law | |
| a. Force between charges | 163 |
| b. Electric fields | 166 |
| 2. Electrostatic Potential | |
| a. Calculating potential | 170 |
| b. Work and energy | 173 |
| c. Spherical and cylindrical charge distributions [C] | 176 |
| d. Deriving E from V [C] | 178 |
| 3. Gauss's law [C] | |
| a. Gauss's law | 179 |
| 4. Free Response Questions | |
| a. Free Response Questions | 181 |
| b. Free Response Questions [C] | 184 |

B. Conductors, Capacitors, and Resistors

| | |
|---|-----|
| 1. Conductors | |
| a. Charge distribution | 186 |
| b. Electric fields | 188 |
| c. Electric potential | 189 |
| 2. Capacitors | |
| a. Capacitance | 190 |
| b. Electric fields in capacitors | 192 |
| c. Energy in a capacitor | 193 |
| d. Spherical and cylindrical capacitors [C] | 184 |
| 3. Resistors | |
| a. Resistivity | 195 |
| 4. Dielectrics [C] | |
| a. Dielectrics | 197 |
| 5. Free Response Questions | |
| a. Free Response Questions | 198 |
| b. Free Response Questions [C] | 201 |

C. Electric Circuits

| | |
|---|-----|
| 1. Current | |
| a. Internal resistance | 202 |
| b. Current density and drift velocity [C] | 203 |
| 2. Resistor Only Circuits | |
| a. Equivalent resistance | 204 |
| b. Currents and ohm's law | 206 |
| 3. Capacitors in Circuits | |
| a. Equivalent capacitance | 211 |
| b. Charge stored on a capacitor | 213 |
| 4. Energy and Power | |
| a. Power dissipated by a resistor | 215 |
| b. Energy stored on a capacitor | 219 |
| 5. RC Circuits [C] | |
| a. Charging and discharging RC Circuits | 220 |
| 6. Free Response Questions | |
| a. Free Resonse Questions | 221 |
| b. Free Response Questions [C] | 227 |

D. Magnetostatics

| | |
|--|-----|
| 1. Force on a Moving Charge | |
| a. Force on a moving point charge | 229 |
| b. Cyclotron equation | 232 |
| 2. Current Carrying Wires | |
| a. Force on a long straight wire | 233 |
| b. Field from a long straight wire | 236 |
| 3. Biot-Savart and Ampere's Laws [C] | |
| a. The Biot-Savart Law | 240 |
| b. Ampere's Law | 241 |
| 4. Free Response Questions | |
| a. Free Response Questions | 242 |
| b. Free Response Questions [C] | 249 |

E. Electromagnetism

| | |
|------------------------------|-----|
| 1. Magnetic Flux | |
| a. Flux through a loop | 251 |
| 2. Electromagnetic Induction | |
| a. Induced EMF | 253 |
| b. Induced current | 256 |
| c. Lenz's law | 259 |

| | |
|--------------------------------------|-----|
| 3. Inductance [C] | |
| a. RL circuits | 261 |
| b. LC circuits | 262 |
| 4. Maxwell's Equations [C] | |
| a. Maxwell's equations | 263 |
| 5. Free Response Questions | |
| a. Free Response Questions | 264 |
| b. Free Response Questions [C] | 268 |

IV. WAVES AND OPTICS [B]

A. Wave Motion

| | |
|----------------------------------|-----|
| 1. Properties of Waves | |
| a. Standing waves | 269 |
| b. Traveling waves | 271 |
| c. Electromagnetic waves | 275 |
| 2. Wave Phenomena | |
| a. Doppler shift | 277 |
| b. Superposition | 279 |
| 3. Free Response Questions | |
| a. Free Response Questions | 281 |

B. Physical Optics

| | |
|----------------------------------|-----|
| 1. Diffraction | |
| a. Diffraction | 283 |
| 2. Interference | |
| a. Interference | 285 |
| 3. Free Response Questions | |
| a. Free Response Questions | 287 |

C. Geometric Optics

| | |
|------------------------------------|-----|
| 1. Reflection and Refraction | |
| a. Reflection | 290 |
| b. Refraction | 292 |
| c. Total internal reflection | 297 |
| 2. Mirrors | |
| a. Planar | 299 |
| b. Convex | 301 |
| c. Concave | 302 |
| 3. Lenses | |
| a. Converging | 304 |
| b. Diverging | 308 |
| 4. Free Response Questions | |
| a. Free Response Questions | 309 |

V. ATOMIC AND NUCLEAR PHYSICS [B]

A. Atomic Physics and Quantum Effects

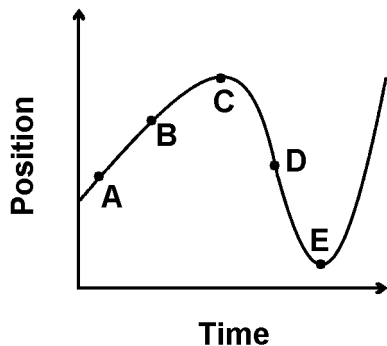
| | |
|--------------------------------|-----|
| 1. Wave/Particle Duality | |
| a. Wave-particle duality | 313 |
| b. Plank's formula | 314 |
| c. DeBroglie wavelength | 315 |
| d. Photoelectric effect | 317 |
| 2. Atomic Structure | |
| a. Rutherford's model | 320 |
| b. The Bohr atom | 321 |
| c. Atomic spectra | 322 |

| | |
|--|-----|
| 3. Free Response Questions | |
| a. Free Response Questions | 325 |
| B. Nuclear Physics | |
| 1. Nuclear Reactions | |
| a. Isotopes, Radiation and Transmutation | 329 |
| b. Fission and fusion | 331 |
| 2. Mass-Energy Equivalence | |
| a. $E = mc^2$ | 333 |
| 3. Half-life | |
| a. Half-life | 334 |
| 4. Free Response Questions | |
| a. Free Response Questions | 337 |
| VI. LAB | 339 |

I. NEWTONIAN MECHANICS

A. Kinematics

Base your answers to questions 8 through 10 on the position versus time graph below which shows the motion of a particle on a straight line.



8. At which of the labeled points is the magnitude of the velocity greatest?

- (A) A (D) D
 (B) B (E) E
 (C) C

9. At which of the labeled points is the velocity zero?

- (A) B only (D) C and D
 (B) E only (E) C and E
 (C) D only

10. At which of the labeled points is the magnitude of the acceleration greatest?

- (A) A (D) D
 (B) B (E) E
 (C) C

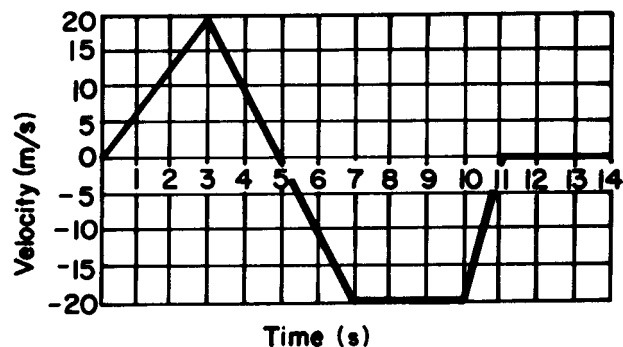
533. An object undergoes constant acceleration. Initially at rest, the object travels 5 m in 1s. What additional distance will be covered in the next second?

- (A) 5 m (D) 20 m
 (B) 10 m (E) 25 m
 (C) 15 m

1. One-Dimensional Motion

a. Graphs of motion

Base your answers to questions 99 and 100 on the graph below which shows the velocity *versus* time for an object moving in a straight line



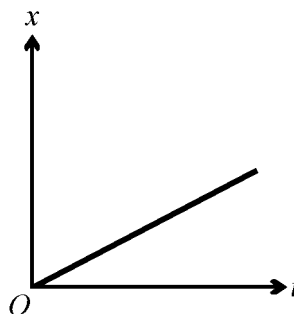
99. At what time after $t = 0$ does the object again pass through its initial position?

- (A) 3 s (D) 9 s
 (B) 5 s (E) 10 s
 (C) 7 s

100. During which interval does the particle have the same average acceleration as $12 \text{ s} < t < 14 \text{ s}$?

- (A) $9 \text{ s} < t < 11 \text{ s}$ (D) $3 \text{ s} < t < 7 \text{ s}$
 (B) $2 \text{ s} < t < 5 \text{ s}$ (E) $5 \text{ s} < t < 11 \text{ s}$
 (C) $0 \text{ s} < t < 3 \text{ s}$

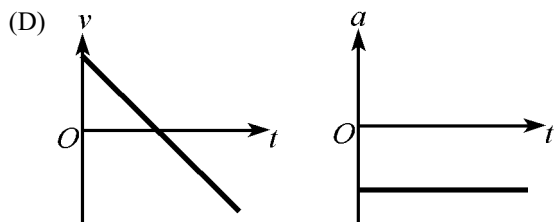
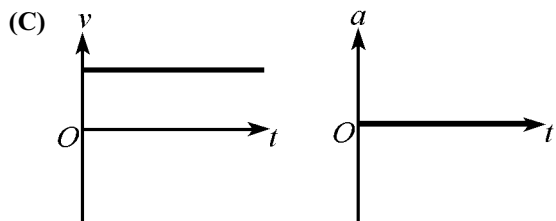
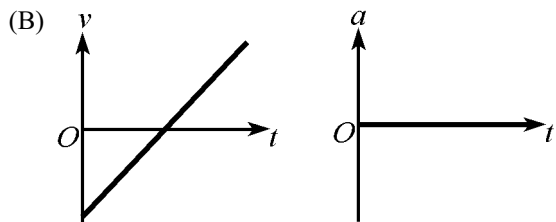
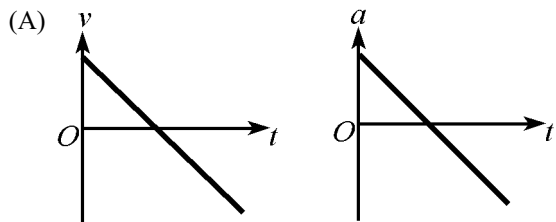
473.



The displacement x of an object moving in one dimension is shown above as a function of time t . The acceleration of this object must be

- (A) zero (D) increasing
 (B) constant and positive (E) decreasing
 (C) constant and negative

1122. An object is fired with an initial velocity v_0 at an initial angle θ_0 with the horizontal. Which of the following pairs of graphs below best represents the horizontal components of the velocity, v , and acceleration, a , of the projectile as functions of time?

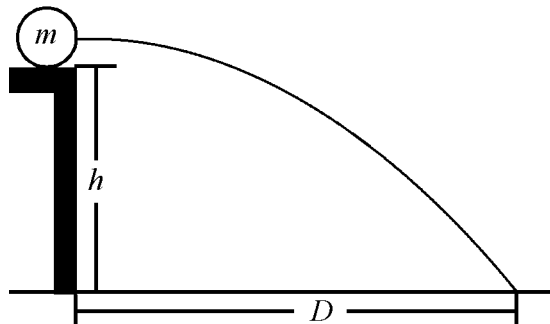


(E) none of the above

1270. A baseball player throws a ball horizontally. Which statement best describes the ball's motion after it is thrown? [Neglect the effect of friction.]

- (A) Its vertical speed remains the same, and its horizontal speed increases.
- (B) Its vertical speed remains the same, and its horizontal speed remains the same.
- (C) Its vertical speed increases, and its horizontal speed increases.
- (D) Its vertical speed increases, and its horizontal speed remains the same.**
- (E) Its vertical speed increases and its horizontal speed decreases.

Base your answers to questions 1404 through 1406 on the following diagram, in which a ball of mass m is rolled horizontally off a table of height h and lands a distance D from the edge of the table.



1404. How much time elapses between the time the ball leaves the edge of the table to when hits the ground?

- (A) hD
- (B) h/D
- (C) hD/g
- (D) $2h/g$
- (E) $\sqrt{2h/g}$**

1405. What is the initial horizontal velocity of the ball?

- (A) $\frac{D}{\sqrt{2h/g}}$
- (B) $D\sqrt{2h/g}$
- (C) $2Dh/g$
- (D) Dhg
- (E) $\frac{g}{Dh}$

1406. If the initial horizontal velocity of the ball is represented as the quantity v , what is the kinetic energy of the ball right before it hits the ground?

- (A) mgh
- (B) $\frac{mv^2}{2}$
- (C) $\frac{mv^2 - 2mgh}{2}$
- (D) $\frac{mv^2 + 2mgh}{2}$**
- (E) $\frac{2mgh - mv^2}{2}$

1773. Rocky the Flying Squirrel is carrying a nut of mass 0.5 kg while flying horizontally at a height of 15 m above the ground at a speed of 12 m/s. Bullwinkle is eagerly awaiting the delivery of the nut on the ground. Rocky releases the nut as he is directly above Bullwinkle. How far from Bullwinkle will the nut land if Bullwinkle does not move?

- (A) $3\sqrt{2}$
- (B) $3\sqrt{3}$
- (C) $6\sqrt{2}$
- (D) $6\sqrt{3}$
- (E) $12\sqrt{3}$**

A. Fluid Mechanics

a. Magnitude of buoyant force

283. A cube 0.4 m on each side and mass of 48 kg floats in water. What fraction of the cube's volume is above the surface of the water?

- (A) $\frac{1}{4}$ (D) $\frac{2}{3}$
- (B) $\frac{1}{3}$ (E) $\frac{3}{4}$
- (C) $\frac{1}{2}$

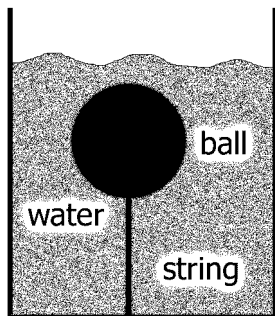
284. A cube 0.2 m on each side floats in water. If 80% of the cube is submerged, what is the mass of the cube?

- (A) 1.6 kg (D) **6.4 kg**
- (B) 4.0 kg (E) 10.0 kg
- (C) 6.25 kg

285. A clay ball has density D and volume V . It is completely immersed in a fluid with density r . Given that $D > r$, what is the magnitude of the balls initial downward acceleration?

- (A) $\frac{r}{D}g$ (D) $(1+\frac{r}{D})g$
- (B) $(\frac{D}{r}-1)g$ (E) $(1+\frac{D}{r})g$
- (C) $(1-\frac{r}{D})g$

286.



The figure above shows a ball of specific gravity 0.8 and volume of .010 m³ attached to a string, the other end of which is fastened to the bottom of a tank. When the tank is filled with water, what is the tension in the string?

- (A) 10 N (D) 60 N
- (B) **20 N** (E) 80 N
- (C) 40 N

287. An object of specific gravity 4 weighs 50 N less while completely submerged in water than it does in air. What is the actual weight of this object?

- (A) 100 N (D) 1000 N
- (B) **200 N** (E) 2000 N
- (C) 400 N

288. An object that weighs 800 N in air weighs 200 N less in water. What is the specific gravity of this object?

- (A) $\frac{1}{4}$ (D) 3
- (B) $\frac{3}{4}$ (E) 4
- (C) $\frac{4}{3}$

973. An object with a volume $2 \times 10^{-2} \text{ m}^3$ floats in a tank of water with 70% of its volume exposed. The weight of this object is

- (A) 3 N. (D) 30 N.
- (B) 6 N. (E) **60 N.**
- (C) 12 N.

Base your answers to questions 1858 and 1859 on the information below.

A uniform block of weight 24 N is placed in a fluid-filled cylindrical tank of depth 10m. The ratio of density of the box to the density of the fluid is 2/3.

1858. What occurs when the block is released?

- (A) The block will sink until it hits the bottom the tank.
- (B) The block will sink until the bottom of the block is 2 meters above the bottom of the tank.
- (C) The block will float with 3/5 of it submerged.
- (D) **The block will float with a 2/3 of it submerged.**
- (E) the block with float with 1/3 of it submerged.

1859. What is the mass, if any, of the portion of the block not submerged in the fluid?

- (A) 0 kg (D) 8 kg
- (B) **0.8 kg** (E) 16 kg
- (C) 1.6 kg

1860. An object is dropped in water and sinks to the bottom. It the magnitude of its acceleration is 8.16 m/s^2 . The density of the object is most nearly

- (A) $3,200 \text{ kg/m}^3$ (D) **$6,000 \text{ kg/m}^3$**
- (B) $4,800 \text{ kg/m}^3$ (E) $6,188 \text{ kg/m}^3$
- (C) $5,600 \text{ kg/m}^3$

1865. A piston with a height 5 m, a mass 4 kg, and a cross sectional area of 0.5 m^2 is released from rest from at the bottom of a tank with a liquid density of 2 kg/m^3 . What is its initial upward acceleration?

- (A) **2.5 m/s^2** (D) 10 m/s^2
- (B) 5 m/s^2 (E) 12.5 m/s^2
- (C) 7.5 m/s^2

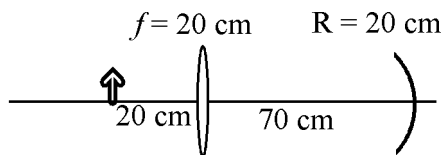
1866. A metal cylinder is released from rest at the bottom of fluid filled tank. It has an initial upward acceleration of a . If the volume of the cylinder is halved, and the density of the fluid is doubled what will the new upward acceleration be? (assume the buoyant force > than the force of gravity on the cylinder)

- (A) $a/4$ (D) $2a$
- (B) $a/2$ (E) $4a$
- (C) **a**

IV. WAVES AND OPTICS [B]

C. Geometric Optics

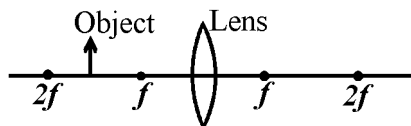
62. The diagram below shows an object 20 cm to the left of a lens with focal length of 20 cm, and a mirror that is a section of a sphere of radius 20 cm and located 70 cm to the right of the lens.



Light passes through the lens, reflects off the mirror, and back through the lens. Where is the final image of the object?

- (A) 30 m right of the lens (D) 30 m left of the lens
 (B) 60 m right of the lens (E) **No image will be formed.**
 (C) 60 m left of the lens

152.



An object is placed as shown in the figure above. The lens in the diagram has a focal length f . As compared to the object, the image formed by the lens is

- (A) upright and larger. (D) inverted and the same size.
 (B) upright and the smaller. (E) inverted and smaller.
 (C) **inverted and larger.**

192. An object is placed 0.30 meter from a lens whose focal length is +0.15 meter. The image is

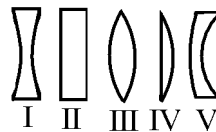
- (A) **inverted, real and 0.30 meter from the lens on the opposite side from the object.**
 (B) upright, virtual, and .30 meter from the lens on the opposite side from the object.
 (C) upright, real, and 0.10 meter from the lens on the same side as the object.
 (D) upright, virtual, and 0.10 meter from the lens on the same side as the object.
 (E) inverted, real and 0.10 meter from the lens on the same side as the object.

470. A 10 centimeter tall object is placed 20 cm from a lens. The image formed is inverted and 2.0 centimeters tall. The focal length of the lens is most nearly

- (A) 4 cm (D) 10 cm
 (B) **5 cm** (E) 20 cm
 (C) 8 cm

3. Lenses a. Converging

337. The set of lenses shown below.



Which of the lenses, when placed in air, will cause parallel rays of light to converge?

- (A) I and III only (D) I, II, and V only
 (B) II, III and I only (E) I and V only
 (C) **III and IV only**

392. If the object distance for a converging thin lens is less than the focal length of the lens, the image is necessarily

- (A) **virtual and erect**
 (B) located inside the focal point
 (C) larger than the object
 (D) real and inverted
 (E) smaller than the object

469. An object is placed 2.0 centimeters from a thin converging lens with a focal length of 6.0 centimeters. The image is

- (A) **virtual and 3.0 cm from the lens.**
 (B) virtual and 6.0 cm from the lens.
 (C) real and 1.5 cm from the lens.
 (D) real and 3.0 cm from the lens.
 (E) real and 6.0 cm from the lens.

471. An object is placed near a converging lens that has a focal length of f . At what distance should the object be placed so that the image is the same height as the object?

- (A) $\frac{1}{2}f$ (D) $4f$
 (B) f (E) infinity
 (C) **$2f$**

472. Which of the following statements is true concerning the image made from a simple magnifying glass?

- (A) **It is always further from the lens than the object.**
 (B) It is always further from the lens than the focal point.
 (C) It is always closer to the lens than the focal point.
 (D) It is always inverted.
 (E) It is always real.

527. Which of the following sorts of images cannot be made by a single converging lens?

- I. virtual and inverted
 II. real and upright
 III. real and inverted
 (A) I only (D) I and III only
 (B) II only (E) I, II, and III
 (C) **I and II only**