1 A block of wood has density half that of water (ρ_W is 10^3 kg/m^3). The block is a cube with each side of length 0.5 m. A 50 kg weight sits on top of the block. What fraction of the block's volume is under water?

1) 0.7   2) 0.5   3) 0.8   4) 0.9   5) 0.6

2 ** Three objects of mass $M_1 = M$, $M_2 = 2M$ and $M_3 = 2M$ lie at the corners of an equilateral triangle of side L. The magnitude of the gravitational force of M_2 on M_3 is 10 N. What is the magnitude of the net gravitational force on M_1 due to M_2 and M_3?

1) 12.2 N   2) 4.83 N   3) 7.22 N   4) 5.96 N   5) 8.66 N

3 A 5 kg mass, that moves along a frictionless surface inclined at an angle of 45° to the horizontal, is attached to a spring which lies parallel to the incline. The mass is slowly lowered until it reaches its equilibrium position, at which point the spring is stretched 0.25 m relative to its unstretched length. What is the value of the spring constant?

1) 285 N/m   2) 248 N/m   3) 212 N/m   4) 173 N/m   5) 139 N/m

4 * An elevated train 20 m above ground moves horizontally with a speed of 10 m/s. A passenger leans out from a window and throws a rock horizontally in the forward direction with a speed of 10 m/s relative to the train. As measured by an observer on the ground, what is the length of the displacement vector from the point at which the rock is thrown to the point at which it lands on the ground?

1) 27 m   2) 45 m   3) 62 m   4) 73 m   5) 96 m

5 * A train on a horizontal track has a speed of 10 m/s in the forward direction. A child on the train throws a ball towards the rear of the train with a speed of 10 m/s at an angle of 60° above the horizontal (as measured on the train). What is the angle of the ball's initial velocity vector above the horizontal as measured by an observer on the ground?

1) 15°   2) 30°   3) 75°   4) 60°   5) 45°

6 ** A 1000 kg auto travels at constant speed around a circular track of radius 150 m. The auto travels without sliding and the track is banked at an angle of 45°. The net force acting on the auto has magnitude 6000 N. How much time is required for the auto to make one complete revolution around the track?

1) 22.6 s   2) 76.2 s   3) 44.4 s   4) 31.4 s   5) 58.9 s

7 * A rock is thrown straight up with an initial speed of 5 m/s from height h and eventually hits the ground. The rock spends twice as much time travelling downwards as it spends travelling up. What is the height h in m?

1) 3.8　　　　　2) 4.6　　　　　3) 5.2　　　　　4) 6.0　　　　　5) 7.1

8 * A rock is thrown with initial speed of 15 m/s from the edge of building A to the edge of building B. The heights of the buildings are the same, and the rock is in the air for 2 s. What is the angle between the rock's initial velocity vector and the horizontal direction?

1) 27°　　　　　2) 41°　　　　　3) 55°　　　　　4) 62°　　　　　5) 74°

9 Water is pumped from a large reservoir over a hill that is 200 m higher than the reservoir, and then down to a town that is 200 m below the reservoir. What is the minimum pressure required of the pump, in N/m^2?

1) 4.81×10^5　　2) 1.00×10^5　　3) 1.96×10^6　　4) 6.67×10^6　　5) 3.92×10^7

10 * Two autos, **A** and **B,** start from rest a distance 300 m apart and accelerate at constant rates towards each other. The magnitude of the acceleration of **A** is twice that of **B**. The autos collide after 10 s. How far does **A** travel in m?

1) 100　　　　　2) 175　　　　　3) 200　　　　　4) 225　　　　　5) 250

11 Cylinder A with moment of inertia 3.00 kg m^2 is spinning with angular velocity 3.00 rad/s. Cylinder B with moment of inertia 6.00 kg m^2 is spinning with angular velocity 2.00 rad/s. The cylinders are suddenly clamped together and spin about the common axis through their centers. What is the resulting kinetic energy of the clamped system?

1) 12.3 J　　　2) 17.4 J　　　3) 24.5 J　　　4) 34.4 J　　　5) 49.0 J

12 ** A 10.0 g bullet travelling horizontally with a speed of 1000 m/s strikes and passes completely through an initially stationary 5 kg block. The speed of the emerging bullet is 500 m/s. What is the block's energy just after the bullet emerges?

1) 0.75 J　　　2) 1.25 J　　　3) 2.50 J　　　4) 3.75 J　　　5) 4.00 J

13 Starting from rest, two cylinders of radius R_A and $R_B = 0.50\ R_A$ roll a distance d down an slope that makes an angle θ with the horizontal. They roll without slipping. They have the same mass and the same speed when they reach the bottom of the slope. If the moment of inertia of cylinder A is 2.00 kg m^2, what is that of cylinder B?

1) 0.25 kg m^2　2) 0.50 kg m^2　3) 0.75 kg m^2　4) 1.00 kg m^2　5) 1.25 kg m^2

14 ** A blob of mass 2.00 kg is dropped from a height of 5.00 m. It hits the ground and rebounds straight up to a height of 2.00 m before falling back to the ground. How much kinetic energy does the blob lose during its first collision with the ground?

1) 16.2 J   2) 21.7 J   3) 33.3 J   4) 42.6 J   5) 58.8 J

15 A 0.5 kg mass is attached to a spring and moves back and forth across a frictionless horizontal surface. The period of the spring's harmonic motion is 0.5 s. The mass is set in motion by being pulled until the spring is stretched by 0.25 m, and is then released from rest. What is the speed of the mass as it passes through its equilibrium position?

1) 1.2 m/s   2) 2.3 m/s   3) 3.1 m/s   4) 4.4 m/s   5) 5.6 m/s

16 Auto A moving at 30 m/s in the positive x direction strikes auto B which is at rest. After the collision, auto B moves with a velocity of 10 m/s at an angle of 30° above the x axis. If autos A and B have equal mass, what is the speed of auto A after the collision?

1) 14 m/s   2) 18 m/s   3) 22 m/s   4) 26 m/s   5) 30 m/s

17 A uniform 25 kg ladder 4 m long leans against a frictionless vertical wall. The ladder just begins to slide when it makes an angle of 60° with the horizontal. What is the coefficient of static friction between the ladder and the floor?

1) 0.67   2) 0.56   3) 0.43   4) 0.29   5) 0.20

18 A water pipes cross sectional area is 4.0 m^2 in section A and it narrows to 1.0 m^2 in section B, which is at a height of 15 m above section A. The pressure in section B is $2.0{\times}10^5$ Pa, and the flow in section A is 4.0 m/s. What is the pressure in section A?

1) $0.20{\times}10^5$ Pa 2) $1.4{\times}10^5$ Pa 3) $2.1{\times}10^5$ Pa 4) $2.7{\times}10^5$ Pa 5) $4.7{\times}10^5$ Pa

19 ** A ball is in equilibrium while suspended from two wires. Wire A makes an angle of 30° with the vertical while wire B makes an angle of 60° with the vertical. The tension in wire B is 20 N. What is the weight of the ball in N?

1) 30   2) 40   3) 50   4) 55   5) 60

20 Satellites A and B, each of mass $1.0{\times}10^4$ kg, are in circular orbit around the Earth. The speed of A is 5.0 times the speed of B. The force of Earth on A is $2.0{\times}10^3$ N. What is the force of Earth on B?

1) 3.2 N   2) 9.8 N   3) $2.0{\times}10^3$ N   4) $4.8{\times}10^3$ N   5) $9.6{\times}10^3$ N