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Multiple Choice Questions (38 Points)

I. PRELIMINARIES (1 pts)

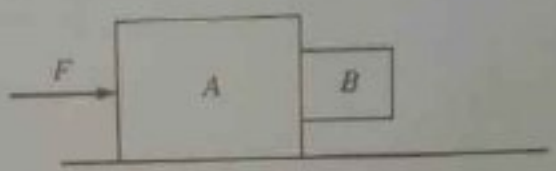
1. Two vectors are given by $\vec{A} = 4i - 3j + k$ and $\vec{B} = -i + j + 4k$. Find a vector $\vec{C}$ such that $\vec{A} - \vec{B} + \vec{C} = 0$

A. $-4i + 3j - k$
B. $-5i + 4j + 3k$
C. $3i - 2j + 5k$
D. $5i - 4j - 3k$
E. $i - j - 4k$

II. KINEMATICS AND DYNAMICS OF PARTICLES (5 pts)

1. For the system consisting of the two blocks shown in the figure, the minimum horizontal force F is applied so that block B does not fall under the influence of gravity. The masses of A and B are 16.0 kilograms and 4.00 kilograms, respectively. The horizontal surface is frictionless and the coefficient of friction between the two blocks is 0.50. The magnitude of F is most nearly

A. 50 N
B. 100 N
C. 200 N
D. 400 N
E. 1,600 N



2. Just as a car starts to accelerate from its initial velocity $4\ m/s$ with acceleration $1.4\ m/s^2$, a bus moving with constant speed of $16\ m/s$ passes it in a parallel lane. How long does it take for the car to overtake the bus?

A. 17.1 s
B. 8.6 s
C. 2.9 s
D. 14.3 s
E. It will never overtake the bus

3. A cannonball is fired with a velocity v. At what angle from the ground must the cannonball be fired in order for it to hit an enemy that is at the same elevation, but a distance d away?

A. $\sin^{-1}(v/gd)$
B. $\sin^{-1}(gd/2v)$
C. $\sin^{-1}(2gd/v)$
D. $(1/2)\sin^{-1}(gd/v^2)$
E. $\sin^{-1}(gd/v^2)$

4. In one-dimensional collision, a particle of mass $2m$ collides with a particle of mass m at rest. If the particles stick together after the collision, what fraction of the initial kinetic energy is lost in the collision?

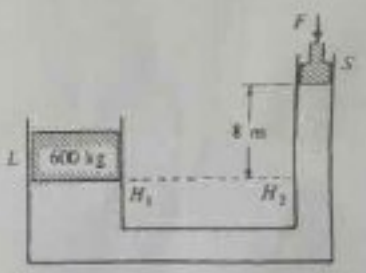
A. 0
B. 1/4
C. 1/3
D. 1/2
E. 2/3

5. A satellite of mass m orbits a planet of mass M in a circular orbit of radius R. The time required for one revolution is
   A. independent of M
   B. proportional to $\sqrt{m}$
   C. linear in R
   D. proportional to $R^{3/2}$
   E. proportional to R^2

III. FLUID MECHANICS (12 pts)

6. Find the ratio of a systolic blood pressure of *120 (in mmHg)* to atmospheric pressure. Standard atmospheric pressure is 1.01×10^5 Pa and density of mercury is $13.6\ g/cm^3$
   A. 1.00
   B. 1.16
   C. 0.16
   D. 0.84
   E. 6.31

7. In the hydraulic system shown in the figure, the cylinder on the left has a mass of *600 kg* and cross-sectional area of $800\ cm^2$. The piston on the right has cross-sectional area $25\ cm^2$ and negligible weight. If the apparatus is filled with oil ($\rho = 0.78\ g/cm^3$), what is the force F required to hold the mass in equilibrium?

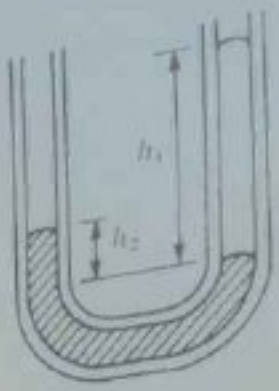


   A. 187.5 N
   B. 62.4 N
   C. 209.8 N
   D. 125.1 N
   E. 31 N

8. A diver in water picks up a lead cube of side length *10 cm*. How much force is needed to lift the cube? The density of lead is approximately $11 g/cm^3$.
   A. 10 N
   B. 11 N
   C. 50 N
   D. 100 N
   E. 110 N

9. A boat floating in fresh water displaces $3.63\ m^3$ of water. What volume of water would this boat displace if it were floating in salt water of density $1024\ kg/m^3$
   A. 3.55 m^3
   B. 3.63 m^3
   C. 3.72 m^3
   D. 7.17 m^3
   E. 0.087 m^3

15. Assume that the two liquids in the U-shaped tube, shown in the figure, are water and oil. Compute the density of the oil if the water stands *19 cm* above the interface and the oil stands *24 cm* above the interface. Density of water is *1000 kg/m³*



A. 1236 kg/m³
B. 5000 kg/m³
C. 792 kg/m³
D. 208 kg/m³
E. 1000 kg/m³

16. An aqueduct consisting of a pipe filled completely with water passes up a hill that is *10 m* high. At the bottom of the hill, a flowmeter measures the speed of the fluid to be *2.0 m/s*. At the top of the hill, a flowmeter measures the speed of the fluid to be *1.0 m/s*. Which is the closest to the difference in the fluid pressure between the bottom and top of the hill?

A. 1.50×10^3 Pa
B. 9.85×10^4 Pa
C. 1.00×10^5 Pa
D. 1.02×10^5 Pa
E. 9.85×10^7 Pa

17. An incompressible fluid of density ρ flows through a horizontal pipe of radius r and then passes through a constriction of radius $r/2$. If the fluid has pressure P_0 and velocity v_0 before the constriction, the pressure in the constriction is

A. $P_0 - (15\rho v_0^2/2)$
B. $P_0 - (3\rho v_0^2/2)$
C. $P_0/4$
D. $P_0 + (3\rho v_0^2/2)$
E. $P_0 + (15\rho v_0^2/2)$

IV. HEAT AND THERMODYNAMICS *(20 pts)*

18. Why a balloon filled with hot air floats

A. The air in balloons expands and becomes more dense than the surrounding air
B. The air in balloons expands and becomes less dense than the surrounding air
C. The air in balloons has no difference in density with the surrounding air
D. None of the above

19. In thermodynamics, the internal energy of any system includes

A. kinetic energy of translation of molecules
B. rotation of molecules
C. potential energy of molecules
D. All of the above

32. Body A has twice the mass and three times the specific heat of body B. They are supplied with equal amounts of heat. Body A experiences a temperature change ΔT. What change in temperature is experienced by body B?

A. ΔT

B. $3\Delta T/2$

C. $2\Delta T/3$

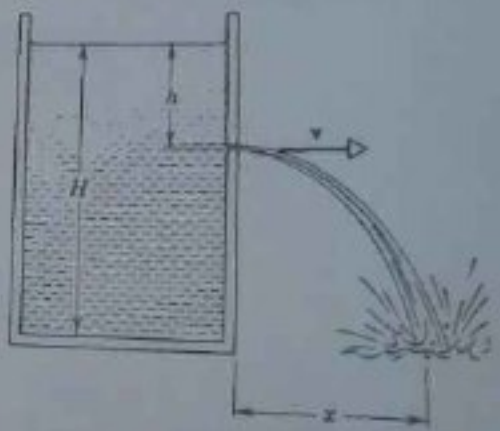
D. $6\Delta T$

Workout Problems (12 Pts)

1. A ball of mass m is launched at 45° from the horizontal by a spring of spring constant k that is compressed by a displacement d. Show that the horizontal distance x the ball travels before landing on the ground is given by kd^2/gm.

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2. A tank is filled with water to a height H. A hole is punched in one of the walls at a depth h below the water surface, as shown in the figure. Show that the horizontal distance x from the edge of the bath where the draining water land is given by $2\sqrt{h(H-h)}$.



3. A 0.050 kg bar of metal is heated to 200.0°C and then immersed into a beaker containing 0.400 kg of water initially at 20.0°C. If the final equilibrium temperature of the mixed system is 22.4°C, find the specific heat of the metal (Take Specific heat of water as 4186 J/kg °C)