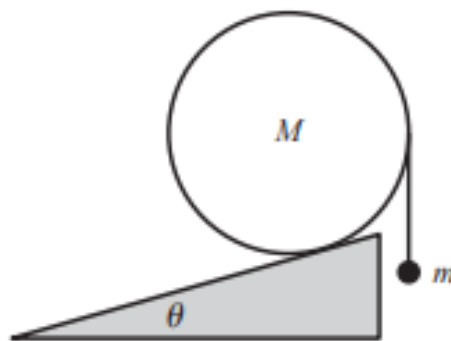




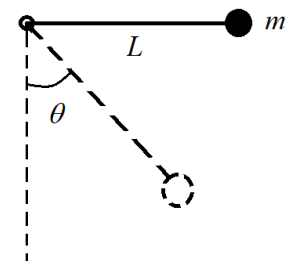
1. A 0.1 kg ball strikes a wall with a speed 4 ms^{-1} with an angle of 60° from the normal. It then reflects elastically. Assuming that the contact time is 0.01 s, what is the average force between the wall and the ball during the time of contact?
 - A. 20 N
 - B. 70 N
 - C. 40 N
 - D. 30 N
 - E. 80 N
2. A ball of mass M rests on a rough incline of angle θ . A string is tied to the rightmost point of the ball with a mass hanging from it. Let the magnitude of normal force and friction force between slope and ball be N and f respectively. Let the magnitude of tension force and gravitational force of the ball be T and G respectively. Which of the following is a valid equation for torque balance?



- A. $fR \cos \theta - TR \sin \theta + GR \sin \theta = 0$
- B. $GR + fR \sin \theta - NR \cos \theta = 0$
- C. $NR \cos \theta + fR - TR = 0$
- D. $TR - fR = 0$
- E. $NR + TR - fR - GR = 0$

Questions 3 and 4 refer to the same text and diagram below.

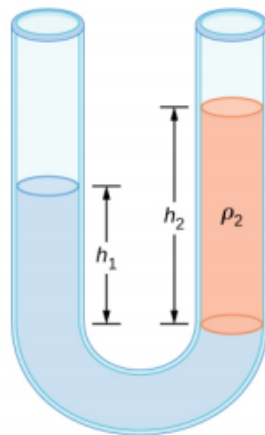
A simple pendulum, consisting of a string tied to a frictionless fixed pivot at one end and a bob of mass m at the other end, is gently released from the horizontal position (i.e. $\theta = 90^\circ$) as shown.



3. After the release, the tension of the string is given by ____.
 - A. $3mg \cos \theta$
 - B. $3mg \sin \theta$
 - C. $mg \cos \theta$
 - D. $mg \sin \theta$
 - E. $4mg \cos \theta$



4. In order for the string not to break during the swing, it must be able to withstand a tension of ____.
- A. $2 mg$
 - B. $4 mg$
 - C. $8 mg$
 - D. $6 mg$
 - E. $3 mg$
5. Consider a circular beaker filled with liquid. The beaker is now spun at a constant angular velocity ω about its centre. What is the shape of the surface of the liquid?
- A. It will remain flat.
 - B. It will be a cone.
 - C. It will be a hyperbola.
 - D. It depends on the magnitude of ω .
 - E. It will be a parabola.
6. Which of the following statements is true about capillary action?
- A. The height of the liquid column depends on the viscosity of the liquid.
 - B. Increasing the surface tension will always increase the height of the liquid column.
 - C. The height of the liquid column can be negative.
 - D. Capillary action works even when there is no gravity.
 - E. The radius of the tube has no effect on the height of the liquid column.
7. Consider the U tube shown below. It is filled with 2 liquids of densities ρ_1 and ρ_2 . What is the relationship between h_1 and h_2 ?



- A. $h_1 = h_2$
- B. $\left(1 + \frac{\rho_2}{\rho_1}\right) h_1 = \left(1 + \frac{\rho_1}{\rho_2}\right) h_2$
- C. $\rho_1^2 h_1 = \rho_2^2 h_2$
- D. $\left(1 + \frac{\rho_1}{\rho_2}\right) h_1 = \left(1 + \frac{\rho_2}{\rho_1}\right) h_2$
- E. $\rho_2 h_1^2 = \rho_1 h_2^2$



8. An iron ring is to fit tightly on a cylindrical iron rod. At 25 °C, the diameter of the rod is 6.492 cm and the inside diameter of the ring is 6.480 cm. To slip over the rod, the ring must be larger than the rod diameter by about 0.008 cm. To what temperature must the ring be heated? Take the coefficient of linear expansion of iron = 12×10^{-6} .
- A. 230 °C
B. 257 °C
C. 282 °C
D. 303 °C
E. 448 °C
9. You have seven point charges of charge $+Q$ and two point charges of charge $-Q$. You wish to arrange these nine point charges to form a regular nine-sided polygon of side length L . What is the largest possible magnitude of electric field at the centre of the polygon?
- A. $0.25 \frac{Q}{\pi \epsilon_0 L^2}$
B. $0.50 \frac{Q}{\pi \epsilon_0 L^2}$
C. $0.47 \frac{Q}{\pi \epsilon_0 L^2}$
D. $3.76 \frac{Q}{\pi \epsilon_0 L^2}$
E. $0.44 \frac{Q}{\pi \epsilon_0 L^2}$
10. A thin wire made of an insulating material is bent into the shape of an equilateral triangle with side length L , and placed in a region with a uniform electric field E . What is the maximum possible electric potential difference between any 2 points on the wire?
- A. $\frac{\sqrt{3}}{2} EL$
B. $\frac{2}{3} EL$
C. $\sqrt{3} EL$
D. EL
E. None of the above



11. 3 polarizers, A, B and C, are placed in that order, parallel to each other. Some initially unpolarized light of intensity I_0 is shone perpendicularly through A. Given that polarizer C is angled at 90° with respect to A, what is the maximum intensity of light emerging from C that can be detected?
- A. I_0
B. $\frac{1}{2}I_0$
C. $\frac{1}{8}I_0$
D. $\frac{1}{4}I_0$
E. None of the above
12. Smoke emits from a chimney at a temperature of 40°C . Assume that the smoke is an ideal gas of molar mass $\mu = 29\text{ g/mol}$ and has molar specific heat at constant volume $c_v = 2.5R$. Given that the atmospheric pressure is uniform at 1 atm and the air temperature is uniform at 20°C , calculate the height the smoke column rises. Neglect any heat exchange between the smoke and the surrounding air.
- A. 1780 m
B. 550 m
C. 726 m
D. 1521 m
E. 311 m

Question	Answer
1	C
2	D
3	A
4	E
5	E
6	C
7	D
8	C
9	E
10	D
11	C
12	A