PHYS 1120 Standards 1–13 Retest 1

Brief Solutions

Standard 1 Retest 1

1. Volume of peridotite

   $\rho = m/V$, so $V = m/\rho$.

2. Bicycle tire contact area

   $p = F/A$, so $A = F/p$.

Standard 2 Retest 1

1. Hydraulic system output force

   $F_1/A_1 = F_2/A_2$, so $F_2 = F_1 A_2/A_1$

2. Conserved quantities in a hydraulic system

   force is not the same
   pressure is the same
   work is the same
   area is not the same
   volume change is the same
   distance is not the same

   I needed to hand grade this question, because I don't like the formula that Canvas uses for multiple correct answer questions. It's fine if a student answers all parts correctly, but not otherwise.

Standard 3 Retest 1

Pressure at the base of a mercury column

Here, use $p = \rho g h$.

Standard 4 Retest 1

1. Water displaced by a floating canoe

   Buoyancy is equal to the weight of water displaced. The canoe is floating, so the buoyancy must equal the weight of the canoe. We then must find the volume of water with the same weight as the canoe. Since the canoe and the water are in the same gravitational field, the they must have the same mass.

$$m = \rho V$$
$$V = m/\rho$$

2. Fraction of an iceberg under water

   The water displaced has the same mass as the entire iceberg and the same volume as the ice that is under the waterline. It produces a buoyancy force that is equal to the entire weight of the ice.

Buoyancy force $\rho_W g V_S = mg$, where ρ_W is the density of water, V_S is the volume of ice under water ("submerged"), and m is the mass of the ice. In terms of the density ρ_I and total volume V of ice, its mass is $m = \rho_I V$. Thus $\rho_W g V_S = \rho_I V g$.

We need to find the ratio of submerged ice volume to total ice volume.

$$\rho_W g V_S = \rho_I V g$$
$$V_S/V = \rho_I/\rho_W$$

3. Buouyancy equivalence

   The buoyancy force on an object immersed in a fluid is equal to the weight of fluid displaced.

Standard 5 Retest 1

1. Mass flow rate

   Volume flow rate is vA. The radius of the pipe is given, so the area is $A = \pi r^2$. vA gives us cubic meters per second, which we need to convert to kilograms per minute.

2. Relationship between pressure and speed

   Pressure is greater where flow speed is slower.

3. Origin of Bernoulli equation

   Conservation of energy

   I had to hand grade this question, because the correct choice was listed twice, and of course only one of them was identified to Canvas.

4. Speed of a spurt

   This is an application of the Bernoulli equation. The heights are the same, so that simplifies our task.

$$p_2 - p_1 = 1/2 \rho v_1^2$$
$$v_1^2 = 2(p_2 - p_1)/\rho$$

Standard 6 Retest 1

1. Capillary action: Effect of contact angle on column height

   The smaller the contact angle, the higher the column.

2. Capillary action: Effect of liquid density on column height

   The denser the liquid, the shorter the column.

3. Capillary action: Effect of capillary thickness on column height

   The narrower the tube, the higher the column.

4. Capillary action: Effect of surface tension on column height

   The higher the surface tension, the higher the column.

Standard 7 Retest 1

1. Effect of viscosity on flow speed

   More viscous fluids flow more slowly.

2. Viscosity in Bernoulli equation

   The Bernoulli equation does not account for viscosity.

Standard 8 Retest 1

Particle A at the origin has a charge of 6.0×10^{-6} C. Particle B at $(-0.60, -0.30)$ m has charge -3.0×10^{-6} C.

1. Attract or repel?

   Charges of opposite signs attract.

2. Electrostatic force magnitude

   $F = kq_1q_2/r^2$. $r^2 = (-0.6\text{ m})^2 + (-0.3\text{ m})^2 = 0.45\text{ m}^2$. Thus $F = (8.99 \times 10^9\text{ N}\cdot\text{m}^2/\text{C}^2)(6.0 \times 10^{-6}\text{ C})(-3.0 \times 10^{-6}\text{ C})/(0.45\text{ m}^2) = -0.3596\text{ N}$

3. General direction of force vector

   Particle A at the origin is attracted to particle B in region e.

4. Specific direction of force vector

   Here we convert the position vector of the particle into degrees counterclockwise of the $+x$ axis. We can use the formula $\tan\theta = y/x$, but we must remember here that the angle is between 90 and 270 degrees, so we must add 180 degrees to the output of the inverse tangent function. $\tan\theta = y/x = (-0.3)/(-0.6) = 0.5$, so $\theta = \arctan(0.5) = 26.6°$. Because x is negative, we need to add 180°, to $\theta = 206.6°$.

5. Magnitude of electric field suspending a balloon

   The force needed is $mg = qE$. Solve for E.

6. Direction of electric field suspending a balloon

   To pull up on a negative charge requires a field pointing down.

Standard 9 Retest 1

1. Unit of potential

   volt = joule per coulomb. I had to hand grade this question because the key was way off.

2. Potential near a + charge

   It takes work to push a positive charge up to another positive charge.

3. Field between capacitor plates

   The field between capacitor plates is uniform. The voltage is the work it takes to push a +1 coulomb charge from the negative plate to the positive plate. $V = Ed$, so $E = V/d$.

Standard 10 Retest 1

1. E field direction

   E field direction is the direction of the force on a + charge.

2. E field strength in a field line diagram

   The field is strong where the lines are closely packed.

3. Charge signs in a field line diagram

   + on the left, where field lines begin. on the right, where field lines end.

4. Greatest E field magnitude

   Between points b, e, and h, the field lines are closest at e.

5. Where the field points left

   The arrows show that happens at points d and f only.

Standard 11 Retest 1

1. Iteraction between charged and uncharged objects

   Always an attraction

2. What explains attraction between charged and neutral objects

   Field points form high V to low V: irrelevant
   All matter contains charged particles: relevant
   Field is perpendicular to isopotential surface: irrelevant
   Electric force weakens with incraseing distance: relevant

   This question needed to be hand-graded.

Standard 12 Retest 1

1. All points in a conductor have the same potential

   True.

2. Conductor in an E field

   Charges inside the conductor move until there is no longer a field to move them further.

Standard 13 Retest 1

Charged conducting sphere

1. Gaussian surface inside the sphere

   The field is zero everywhere at the Gaussian surface, because the electric field is zero everywhere inside a conductor.

2. Electric flux through the Gaussian surface

   The flux must be zero through the surface, because there is no field at the surface.

3. Electric charge enclosed

   The Gaussian surface encloses zero charge, because Gauss's law requires that the flux through an enclosing surface is directly proportional to the total charge contained.

This tells us that if a conductor bears an electric charge, all the charge is at its surface. It does not contain any unbalanced charge in its interior.