

Answer sheet- Group-C (Rangpur division)

Substantial Mark (80%) of the partial marks must be awarded for correct procedure but wrong numerical number.

1. The distance covered is $v^2/4g \sin(\theta)$. (2 marks for the correct answer)

Identification of the frictional force is equal to $mg \sin(\theta)$ deserves 0.8.

Application of Energy conservation another 0.6

2. $B_x = C_x - A_x = -15 \cos(60) - 12 \cos(30) = -17.9$ (0.9 marks)

$B_y = C_y - A_y = 15 \sin(60) - 12 \sin(30) = 7$ (0.9 Marks)

The magnitude of B = 19.2 (0.6 marks)

The angle made = $\tan^{-1}(7/-17.9) = 158.6$ degrees. (0.6 marks)

3. Use of Triangle law of equilibrium \Rightarrow 1 mark

Getting the value of Tension in cord 1 = 104N (0.8 Marks)

Getting the value of Tension in cord 2 = 134N (0.8 Marks)

Getting the value of Tension in cord 3 = 147N (0.4 Marks)

If $g=10 \text{ m/s}^2$ is used the values will be 106N, 137N, 150N. (This is also a valid set of numbers

Deserving Full marks)

4. Common acceleration $a = T_3 / (m_1 + m_2 + m_3) = 0.97 \text{ m/s}^2$ (1 mark)

$T_1 = m_1 a = 11.6\text{N}$ (0.4 Marks)

$T_2 = (m_1 + m_2) a = 34.9\text{N}$ (0.6 Marks)

5. Total Work done is zero (no change in K.E.) \Rightarrow 0.6 marks

Work done by gravity = $-mgh = 367\text{J}$ (0.4+0.3 Marks)

Work done by Rope = $+367 \text{ J}$ (0.7 Marks)

Alternatively if the work done by rope is obtained in any other way \Rightarrow 0.7 marks

6. Heat lost by calorimeter and hot water = $(4.2 \times 380 + 1.62 \times 4200) (70 - t)$ (0.7 Marks)

Heat gained by ice = $1.05 (336000 + 4200 t)$ (0.7 Marks)

Correct value of the final temperature , $t = 18.36$ Celsius (0.6 Marks)

7. Direction of the electric field is towards the left horizontally (1 mark)

The value of the E-field at the point P

$$2 x q / (4 \pi \epsilon_0 (x^2 + y^2)^{3/2}) \text{ (1 mark)}$$

Getting the correct powers of x and y in the denominator (0.4 Marks). Getting the factor of x in the numerator (0.3 marks) . The factor of 2 in the numerator (0.1 mark) An alternative way of writing the E field is $2 q \cos (\theta) / 4 \pi \epsilon_0 r^2$ with $r=5$ m and $\cos (\theta) = 3/5$. (1 mark)

Numerical value of E = 1.38×10^{-10} N/c (1 mark)

8. $V_x = U_x + a_x t = -2 + (3 \cos (130)) (5) = -11.6$ m/s (1 mark)

$$V_y = U_y + a_y t = 4 + (3 \sin (130)) (5) = 15.5$$
 m/s (1 mark)

Values within ± 0.5 is acceptable.

9. Due to the presence of the horizontal constant acceleration, the “effective” acceleration due to Gravity is $\sqrt{(10^2 + 9.8^2)} = 14$ m/s (1.5 marks)
Using the simple pendulum formula with this effective “g” gives a time period of about 7.5 secs. (1.5 marks)

10. When the two droplets meet the net charge is doubled (0.5 marks)

And as the volume is also doubled (0.5 marks) and the radius goes as the 3rd root of the volume it increases by a factor of $2^{1/3}$ (1 mark). The electric potential of a charged conducting sphere goes as Q/R . So, the new potential will increase by a factor of $2^{2/3}$ (2 marks)

11. At any vertex we will have two sides with currents flowing away from and towards the vertex. So, these two sides will have no contribution to the B field. (1.5 marks)

The contribution from the third side will be (using Biot Savart law)

$$2 \mu_0 I \sin (30) / (4 \pi a \cos (30)) . \text{ (2.5 marks)}$$

Having $\sin(30)$ in numerator \Rightarrow (0.5 marks), the $\cos(30)$ factor in denominator \Rightarrow (0.5 Marks)

The factor “a” in the denominator \Rightarrow (0.5 marks)