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SOLUTIONS: AREAS OF PARALLELOGRAMS AND TRIANGLES

Mathematics | Class IX (2026/SOL-ARPARA/09/001)

Section A: Multiple Choice Questions

1. (b) 1 : 2

Reason: Area of triangle = $\frac{1}{2} \times \text{base} \times \text{height}$, Area of parallelogram = base \times height.

2. (c) 30 cm^2

Reason: The sum of areas of triangles formed by a point on the opposite side is half the area of the parallelogram.

3. (a) 1 : 1

Reason: Areas of parallelograms on equal bases and between the same parallels are equal.

4. (b) 4 cm^2

Reason: Joining mid-points divides the triangle into 4 triangles of equal area. $\text{Area}(\triangle DEF) = \frac{1}{4} \times 16 = 4 \text{ cm}^2$.

5. (c) Remains same

Reason: New Area = $(2 \times \text{base}) \times (\frac{1}{2} \times \text{height}) = \text{base} \times \text{height}$.

6. (d) Triangles of equal area

Reason: Median divides a triangle into two triangles of equal area.

7. (a) $\frac{1}{2} \text{ area}(PQRS)$

Reason: Property of any point inside a parallelogram regarding triangles on opposite bases.

8. (a) 1 : 1

Reason: Both are parallelograms sharing the same base and parallels.

Section B: Very Short Answer Questions

1. **Proof:** $\triangle DAC$ and $\triangle EAC$ are on the same base AC and between same parallels $AC \parallel DE$.
 $\therefore \text{area}(\triangle DAC) = \text{area}(\triangle EAC)$. Adding $\text{area}(\triangle ABC)$ to both sides: $\text{area}(\triangle DAC) + \text{area}(\triangle ABC) = \text{area}(\triangle EAC) + \text{area}(\triangle ABC) \implies \text{area}(ABCD) = \text{area}(\triangle ABE)$.

2. **Proof:** Diagonal AC of $\parallel^m ABCD$ forms $\triangle ABC$ and $\triangle ADC$. In these triangles, $AB = CD$, $BC = AD$, and AC is common. By SSS congruence, $\triangle ABC \cong \triangle ADC$. Congruent triangles have equal areas.

3. **Proof:** AD is median $\implies \text{area}(\triangle ABD) = \frac{1}{2} \text{ area}(\triangle ABC)$. In $\triangle ABD$, BE is median (since E is mid-point of AD). $\therefore \text{area}(\triangle BED) = \frac{1}{2} \text{ area}(\triangle ABD) = \frac{1}{2} (\frac{1}{2} \text{ area}(\triangle ABC)) = \frac{1}{4} \text{ area}(\triangle ABC)$.

4. **Proof:** Join HF . $ABFH$ and $HFCD$ are parallelograms. $\text{Area}(\triangle HGF) = \frac{1}{2} \text{ Area}(HFCD)$ and $\text{Area}(\triangle HEF) = \frac{1}{2} \text{ Area}(ABFH)$. Summing these gives $\text{area}(EFGH) = \frac{1}{2} \text{ area}(ABCD)$.

Section C: Short Answer Questions

- Proof:** Join CD . $Area(\triangle BCD) = \frac{1}{2}Area(\triangle ABC)$ (since D is mid-point). $\triangle PDQ$ and $\triangle PDC$ are on same base PD and between $PD \parallel CQ$. $\therefore area(\triangle PDQ) = area(\triangle PDC)$.
 $Area(\triangle BPQ) = area(\triangle BPD) + area(\triangle PDQ) = area(\triangle BPD) + area(\triangle PDC) = area(\triangle BCD) = \frac{1}{2}area(\triangle ABC)$.
- Proof:** (i) Parallelograms $PQRS$ and $ABRS$ are on the same base SR and between same parallels $SR \parallel PB$. Hence, $area(PQRS) = area(ABRS)$. (ii) $\triangle AXS$ and $\parallel^{gm} ABRS$ are on the same base AS and between $AS \parallel BR$. $\therefore area(\triangle AXS) = \frac{1}{2}area(ABRS) = \frac{1}{2}area(PQRS)$.
- Proof:** $area(\triangle AOD) = area(\triangle BOC)$. Adding $area(\triangle DOC)$ to both sides: $area(\triangle AOD) + area(\triangle DOC) = area(\triangle BOC) + area(\triangle DOC) \implies area(\triangle ADC) = area(\triangle BDC)$. Since these triangles have equal areas and share the same base DC , they must lie between the same parallels. Thus $AB \parallel DC$, making $ABCD$ a trapezium.

Section D: Long Answer Questions

- Proof:** $\triangle ABE$ and parallelogram $EBCY$ (where Y is intersection) share same base BE and parallels? No. Note: $area(\triangle ABE) = area(\triangle CBE)$ (Same base BE and $BE \parallel AC$). Also, $\triangle ACF$ and $\triangle BCF$ are on same base CF and $CF \parallel AB$. $\triangle BCF$ and $\triangle CBE$ are on same base BC and $BC \parallel EF$. $\therefore area(\triangle CBE) = area(\triangle BCF)$. Thus, $area(\triangle ABE) = area(\triangle ACF)$.
- Proof:** Let AB be the base. For equal areas, the altitude h of the parallelogram must equal the side AF of the rectangle (since $Area_{rect} = AB \times AF$ and $Area_{para} = AB \times h$). In the parallelogram, let AD be the other side. The altitude h is the perpendicular distance, while AD is the slant side (hypotenuse). In a right triangle, hypotenuse $>$ altitude ($AD > h$). Perimeter of Rectangle = $2(AB + AF)$. Perimeter of Parallelogram = $2(AB + AD)$. Since $AD > h$ and $h = AF$, then $AD > AF$. $\therefore 2(AB + AD) > 2(AB + AF)$.

Section E: Case Study Based Questions

- (c) $600 m^2$ (PM is median, so half area).
- (b) $400 m^2$ ($Area = \frac{1}{3}Area(\triangle PQR)$ for centroid/ratio 2 : 1).
- (a) $area(\triangle POQ) = area(\triangle POR)$ (By symmetry/ratio property).
- (b) Rs.20,000 ($Area(POQ) = 400 m^2$. Cost = $400 \times 50 = 20,000$).
- (b) **1 : 3** ($400 : 1200 = 1 : 3$).