1. (1D Vertical motion with $a = \pm g$, $g = 10 \text{ m/s}^2$, 20%) A 2-m height person throws a stone vertically to the sky with an initial speed of 10 m/s. (a) how long it takes to reach the maximum height? Ans. 1 s; (b) find the maximum height it can reach from ground? Ans. 1.5 m; (c) How long does it take for the stone to return to the ground from the top? Ans. $\sqrt{15}$ s; (d) the stone speed just before reaching to the ground? Ans. $10 \sqrt{2}$ m/s

2. (2D kinematics, 30%) As shown in Fig. 1, an object is launched from the ground with a speed of 40 m/s in an angle of 60 degrees from horizontal and lands on ground. Use $g = 10 \text{ m/s}^2$ for this problem.
   (a) What is horizontal initial-launching speed? Ans. $20 \text{ m/s}$
   (b) What is the vertical initial-launching speed? Ans. $\sqrt{3} \times 20 \text{ m/s}$
   (c) How long does the object take to reach to the maximum height? Ans. $2 \sqrt{3}$ s
   (d) What is the maximum height the object can reach above the ground? Ans. 60 m
   (e) How long does it take for the object to reach the ground after reaching the maximum height? Ans. $2 \sqrt{3}$ s
   (f) How far does the object fly horizontally? Ans. $\sqrt{3} \times 20 \text{ m}$

3. (Dynamics of motion, net-force, 25%) A mass block is initially at rest on a frictionless solid table top and three forces (F1, F2, & F3) are being applied as indicated at t = 0.

   Given F1 = 200 N, F2 = 20 N, F3 = 100 N, and m = 20 kg.
   Find:
   a) Gravitational force on the block, Ans. $200 \text{ N}$
   b) Normal force on the block, Ans. $220 \text{ N}$
   c) Net force on the block, Ans. $100 \text{ N}$
   d) Acceleration of block at t = 0, Ans. $5 \text{ m/s}^2$
   e) Indicate the direction of acceleration on the diagram.

4. (Energetics, 25%) Refer to the problem #3, at time t = 2 second, the block is being displaced to a new location, $\Delta x$ away from the initial location. Find: a) The work done by the net force, Ans. 1000 J; b) Kinetic energy of the block at 2 second, Ans. 1000 J

Fig. 1

\[ V_0 = 40 \text{ m/s} \]

60°

Reference equations:

<table>
<thead>
<tr>
<th>Kinematics (a = 0)</th>
<th>$x = x_0 + v_0 t$</th>
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</thead>
<tbody>
<tr>
<td>Kinematics (a \neq 0)</td>
<td>$v = v_0 + at$</td>
</tr>
<tr>
<td>Dynamics and Energetics</td>
<td>$F = ma$</td>
</tr>
</tbody>
</table>

Note: $\sin(60^\circ) = \cos(30^\circ) = \sqrt{3}/2$  $\cos(60^\circ) = \sin(30^\circ) = 1/2$