Kinematics - 2018

1. 9702/11/M/J/18/No.6
A tennis ball falls freely, in air, from the top of a tall building.

Which graph best represents the variation with time \( t \) of the distance \( s \) fallen?

\[ \text{Graphs A, B, C, D} \]

2. 9702/11/M/J/18/No.7
The graph shows the variation with mass of the weight of objects on a particular planet.

\[ W = mg, \quad g = \frac{W}{m} = \text{gradient} \]
\[ = \frac{4-0}{2-0} = 2 \text{N/kg} \]
\[ = 1.6 \text{ms}^{-2} \]

What is the value of the acceleration of free fall on the planet?

A 0.63ms\(^{-2}\)  B 1.6ms\(^{-2}\)  C 3.2ms\(^{-2}\)  D 9.8ms\(^{-2}\)
3. 9702/12/M/J/18/No.5
The velocity of an object changes with time $t$ as shown.

\[ \text{velocity} \]

\[ 0 \quad 0 \quad x \quad t \]

Which graph best shows the variation with time $t$ of the displacement $s$ of the object?

- [A]
- [B]
- [C]
- [D]
4. 9702/12/M/J/18/No.6
A projectile is launched at an angle to the horizontal at time $t = 0$. It travels over horizontal ground, as shown.

Assume that air resistance is negligible.

Which graph best shows the variation with $t$ of the speed of the projectile from when it is launched to when it lands on the ground?

5. 9702/13/M/J/18/No.6
A rock on the surface of Mars is projected vertically upwards with an initial speed of $9.4\text{ms}^{-1}$. The rock rises to a height of $12\text{m}$ above the surface.

Assume there is no atmosphere on Mars.

What is the acceleration of free fall near the surface of Mars?

<table>
<thead>
<tr>
<th></th>
<th>A 0.39\text{ms}^{-2}</th>
<th>B 3.7\text{ms}^{-2}</th>
<th>C 7.4\text{ms}^{-2}</th>
<th>D 9.8\text{ms}^{-2}</th>
</tr>
</thead>
<tbody>
<tr>
<td>At max. height</td>
<td>$v = 0$</td>
<td>$u\text{te equation}$</td>
<td>$\frac{g}{2\times12}$</td>
<td>$g = 7.68$</td>
</tr>
<tr>
<td>$s = 12\text{m}$</td>
<td>$u = 9.4\text{ms}^{-1}$</td>
<td>$2gs = u^2$</td>
<td>$g = \frac{9.4^2}{2\times12}$</td>
<td></td>
</tr>
<tr>
<td>$g = ?$</td>
<td>$s = 12\text{m}$</td>
<td>$u = 9.4\text{ms}^{-1}$</td>
<td>$g = \frac{9.4^2}{2\times12}$</td>
<td>$g = 7.68$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$g = 7.68\text{ms}^{-2}$</td>
</tr>
</tbody>
</table>
6. Two masses, $M$ and $m$, are connected by an inextensible string which passes over a frictionless pulley. Mass $M$ rests on a frictionless slope, as shown.

The slope is at an angle $\theta$ to the horizontal.

The two masses are initially held stationary and then released. Mass $M$ moves down the slope.

Which expression **must** be correct?

\[
\begin{align*}
\text{A } \sin \theta &< \frac{m}{M} \\
\text{B } \cos \theta &< \frac{m}{M} \\
\text{C } \sin \theta &> \frac{m}{M} \\
\text{D } \cos \theta &> \frac{m}{M}
\end{align*}
\]

\[
\begin{align*}
\sin \theta &= \frac{Mg - mg}{W} = \frac{Mg}{W} - 1 \\
\cos \theta &= \frac{Mg}{W} \\
\text{so } \frac{m}{M} &= \frac{1}{\cos \theta} < 1.
\end{align*}
\]

\[
\sin \theta + \frac{m}{M} = 4.
\]

\[
\sin \theta > \frac{m}{M}.
\]

7. A stone of mass $m$ is dropped from a tall building. There is significant air resistance. The acceleration of free fall is $g$.

When the stone is falling at a constant (terminal) velocity, which information is correct?

<table>
<thead>
<tr>
<th></th>
<th>magnitude of the acceleration of the stone</th>
<th>magnitude of the force of gravity on the stone</th>
<th>magnitude of the force of air resistance on the stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$g$</td>
<td>zero</td>
<td>$mg$</td>
</tr>
<tr>
<td>B</td>
<td>zero</td>
<td>$mg$</td>
<td>$mg$</td>
</tr>
<tr>
<td>C</td>
<td>zero</td>
<td>zero</td>
<td>$mg$</td>
</tr>
<tr>
<td>D</td>
<td>zero</td>
<td>$mg$</td>
<td>zero</td>
</tr>
</tbody>
</table>

At terminal velocity:

\[
\text{Weight} = \text{air resistance} \\
W = mg, \text{ so air resistance} = mg.
\]
8. 9702/12/F/M/18/No.8
The velocity-time graph for an object is shown.

![Velocity-time graph](image)

How can the total displacement of the object be determined?

A. area 1 – area 2
B. \( \frac{\text{area 1} + \text{area 2}}{2} \)
C. area 1 + area 2
D. area 2 – area 1

A. Area 1 = going forward
B. Area 2 = object reversing
C. Displacement = distance from start point to finish point

9. 9702/12/F/M/18/No.9
A girl throws a ball vertically upwards. It takes a time of 3.20 s to return to her hand.

Assume air resistance is negligible.

What is the initial speed with which the ball is thrown?

A. 3.07 ms\(^{-1}\)  B. 7.85 ms\(^{-1}\)  C. 15.7 ms\(^{-1}\)  D. 31.4 ms\(^{-1}\)

Time of flight, \( t = 3.20 \) s

\( S = 0 \) (displacement from start point)

\( S = ut - \frac{1}{2}gt^2 \)

\( 0 = ut - \frac{1}{2}gt^2 \)

\( ut = \frac{1}{2}gt^2 \)

\( u = \frac{1}{2}gt \)

\( = \frac{1}{2} \times 9.81 \times 3.2 \)

\( = 15.696 \) ms\(^{-1}\)