Teacher notes

Common multiple choice questions

A very common type of multiple choice questions on Paper 1 involve problems like:

A body dropped from rest from a height *H* takes *t* seconds to reach the ground. How much time would the body take to drop from a height of 4*H*? Air resistance is ignored.

The idea is to write a formula describing the situation: here the formula has to be $s=\frac{1}{2}at^2$ with s = *H* and *a* = *g* so that in fact $H=\frac{1}{2}gt^2$. We are interested in the time so solve for time to get $t=\sqrt{\frac{2H}{g}}$. You can now proceed in two ways:

Method 1

Write the formula again for the new situation:

$t'=\sqrt{\frac{2\times 4H}{g}}$ don't multiply $2\times 4=8$; leave the 4 alone

$t'=2\sqrt{\frac{2H}{g}}$ take the 4 out of the root, the expression in blue is the old time

$t'=2t$

Method 2

Write the equations for the 2 times:

$t=\sqrt{\frac{2H}{g}}$; $t'=\sqrt{\frac{2\times 4H}{g}}$ (don't multiply 2×4) and now divide side by side:

$$\frac{t'}{t}=\frac{\sqrt{\frac{2\times 4H}{g}}}{\sqrt{\frac{2H}{g}}}=\frac{2\times\sqrt{\frac{2H}{g}}}{\sqrt{\frac{2H}{g}}}=2$$

You can now try these:

1. $s=\frac{1}{2}at^2$. If *a* = const and *t* is doubled, what happens to *s*?
2. $s=\frac{1}{2}at^2$. If *a* = const and *s* is doubled, what happens to *t*?

3. $v^2 = 2as$. If a = const and s is doubled, what happens to v?

4. $v^2 = 2as$. If a = const and v is doubled, what happens to s?

5. $R = \dfrac{u^2 \sin(2\theta)}{2g}$. If u, θ = const and g is halved, what happens to R?

6. $H = \dfrac{u^2 \sin^2 \theta}{2g}$. If u, θ = const and g is halved, what happens to H?

7. $PV = nRT$ where n, R = const. If T is halved and V is doubled, what happens to P?

8. $P = \dfrac{1}{3}\rho c^2$. If P is doubled and ρ is halved, what happens to c?

9. $\dfrac{1}{2}mc^2 = \dfrac{3}{2}kT$. If m, k = const and c is doubled, what happens to T?

10. $\dfrac{1}{2}mc^2 = \dfrac{3}{2}kT$. If m, k = const and T is doubled, what happens to c?

11. $h = \dfrac{v^2}{2g}$. If v = const and g is doubled, what happens to h?

12. $h = \dfrac{v^2}{2g}$. If v and g are both doubled, what happens to h?

13. $E = \dfrac{1}{2}kx^2$. If k = const and E is doubled, what happens to x?

14. $F = \dfrac{kq_1q_2}{r^2}$. If q_1, q_2, k = const and r is doubled, what happens to F?

15. $F = \dfrac{kq_1q_2}{r^2}$. If k = const and q_1, q_2 and r are all doubled, what happens to F?

16. $F = \dfrac{kq_1q_2}{r^2}$. If q_1, q_2, k = const and F is quadrupled, what happens to r?

17. $f = \dfrac{\mu_0 I_1 I_2}{2\pi r}$. If μ_0 = const and r is halved, what happens to f?

18. $T^2 = kR^3$. If k = const and R is quadrupled, what happens to T?

19. $T^2 = kR^3$. If k = const and T increases by a factor of 27, what happens to R?

20. $R = R_0 A^{\frac{1}{3}}$. If R_0 = const and A becomes 8 times larger, what happens to R?

21. $\rho = \dfrac{A}{R^3}$. If $R = R_0 A^{\frac{1}{3}}$ with R_0 = const and A is doubled, what happens to ρ ?

22. $R = \rho \dfrac{L}{A}$ with $A = \pi r^2$. If ρ = const and L and r double, what happens to R?

23. $b = \dfrac{\sigma A T^4}{4\pi d^2}$. If σ , A = const and T and d double, what happens to b?

24. $\lambda = \dfrac{h}{\sqrt{2meV}}$. If h, m, e = const and V is quadrupled, what happens to λ ?

25. $v = \sqrt{\dfrac{2GM}{R}}$. If G, M = const and R is halved, what happens to v?

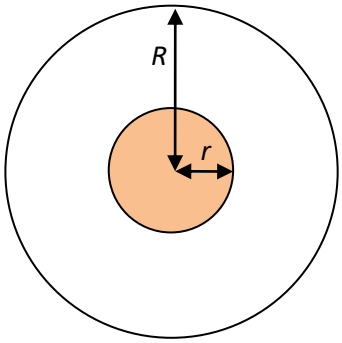
26. $E = \frac{1}{2}m\omega^2 A^2$ and $\omega^2 = \frac{k}{m}$ with k = const. If m is doubled what happens to E?

27. $E = \frac{1}{2}I\omega^2$ where $I = \frac{1}{2}MR^2$ and $\omega = \frac{v}{R}$ with M, v = const. If R is doubled what happens to E?

28. If the side of a square triples what happens to the area?

29. If the radius of a sphere doubles what happens to the volume?

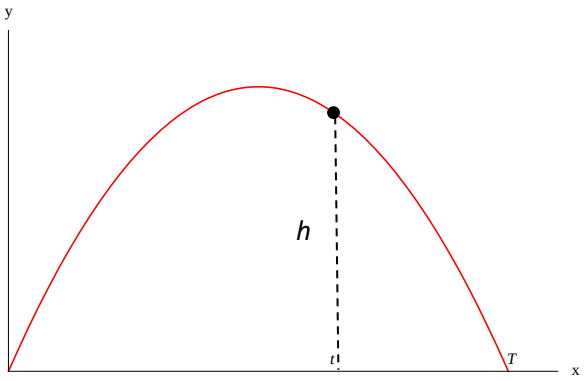
30. A sphere has radius R, mass M and uniform density.



What is the mass enclosed within a distance r from the centre?

In multiple choice questions you can often find the correct answer simply by quick elimination of the ones that are wrong! A typical example is this question:

A ball is thrown vertically upwards. The graph shows the variation with time of the height of the ball. The ball returns to its starting height at time T.



What is the height h at time t?

A $\frac{1}{2}gt^2$ B $\frac{1}{2}gT^2$ C $\frac{1}{2}gT(T-t)$ D $\frac{1}{2}gt(T-t)$

A is eliminated because *h* increases without bound (and does not give zero when *t* = *T*).

B is eliminated because it gives a constant *h* (and does not give zero when *t* = *T*).

C is eliminated because *t* = 0 does not give zero height.

So D has to be correct without checking it!

Trying to actually derive the correct answer for the height would take too much time for a multiple choice question:

$$h = ut\sin\theta - \frac{1}{2}gt^2$$

$$T = \frac{2u\sin\theta}{g} \Rightarrow u\sin\theta = \frac{gT}{2}$$

$$h = \frac{gTt}{2} - \frac{1}{2}gt^2$$

$$h = \frac{gt}{2}(T - t)$$

Too long for Paper 1!

Answers

1. Increases by a factor of 4.
2. Increases by a factor of $\sqrt{2}$.
3. Increases by a factor of $\sqrt{2}$.
4. Increases by a factor of 4.
5. Increases by a factor of 2.
6. Increases by a factor of 2.
7. Decreases by a factor of 4.
8. Increases by a factor of 2.
9. Increases by a factor of 4.
10. Increases by a factor of $\sqrt{2}$.
11. Decreases by a factor of 2.
12. Increases by a factor of 2.
13. Increases by a factor of $\sqrt{2}$.
14. Decreases by a factor of 4.
15. Stays the same.

16. Decreases by a factor of 2.
17. Increases by a factor of 2.
18. Increases by a factor of 8.
19. Increases by a factor of 9.
20. Increases by a factor of 2.
21. Stays the same.
22. Decreases by a factor of 2.
23. Increases by a factor of 4.
24. Decreases by a factor of 2.
25. Increases by a factor of $\sqrt{2}$.
26. Stays the same.
27. Stays the same.
28. Increases by a factor of 9.
29. Increases by a factor of 8.
30. $M(\frac{r}{R})^3$