Higher Grade Physics

OUR DYNAMIC UNIVERSE

Motion –Equations & Graphs

Vector Revision

1. A man walks 500 m due North then 1200 m due West. Use a scale diagram to find his final displacement from his starting point. What was the distance travelled ?

2. What is the final displacement of a yacht which sails 5.0 km due West, followed by 3.2 km South-East ?

3. Find the final displacement of a sailboard which sails 400 m due South; then 300 m due East; and finally 400 m due North-East.

4. A model aircraft is flying north with a velocity of 24 ms^{-1}. A wind is blowing from west to east at 10 ms^{-1}. What is the resultant velocity of the plane?

5. A ship is sailing East at 4 ms^{-1}. A passenger walks due North at 2 ms^{-1}.
   What is the resultant velocity of the passenger relative to the sea?

6. A car travels 50 km N and then returns 30 km S. The whole journey takes 2 hours.
   Calculate: a) the distance travelled
   b) the average speed
   c) the displacement
   d) the average velocity.

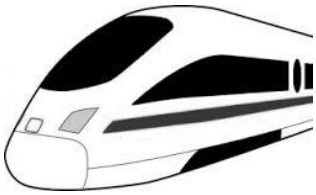
7. Find the average speed and average velocity of the following. An orienteer who runs 5 km due South, 4 km due West and then 2 km North in 1 hour.

Velocity and Acceleration

8. A vehicle accelerates from rest to a speed of 20 ms^{-1} in 5 s; it then travels at a steady speed for 10 s; finally, it decelerates to rest in a further 10 seconds. Sketch a speed-time graph for the vehicle's journey and use it to find the total distance travelled and the average speed.

9. Find the acceleration in each of the following cases :

   (a) a bullet accelerating from rest to a speed of 200 ms^{-1} in 50 milliseconds;
   (b) a train coming to rest from 30 ms^{-1} in 60 s.



10. A train starts from rest and accelerates at 0.5 ms^{-2} for 24 s . What is the final speed?

11. A car traveling at 15 ms^{-1} accelerates at 1.6 ms^{-2} for 8 s. What is the final speed?

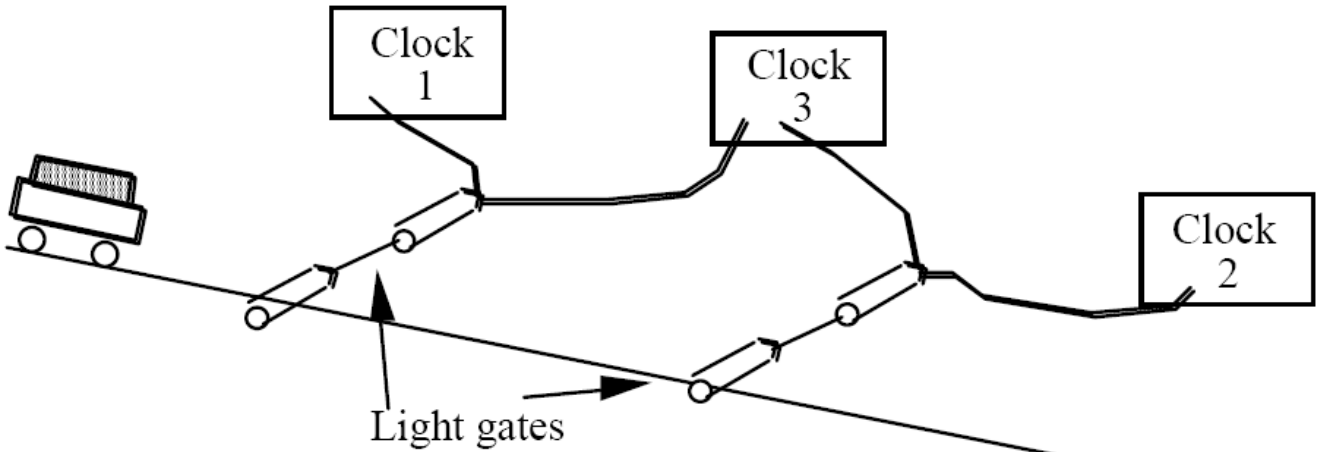
12. A vehicle comes to rest after decelerating at 1.2 ms^{-2} for 6 s. What was its initial speed?

13. How long does it take a car accelerating from rest at 1.2 ms^{-2} to reach a speed of 35 ms^{-1}?

14. How long would a train take to increase its speed from 24 ms^{-1} to 36 ms^{-1} if it is capable of accelerating at 0.4 ms^{-2}?

15. Friction causes a trolley to decelerate at 50 cms^{-2}. How long would it take to slow down from 2.25 ms^{-1} to 0.50 ms^{-1} ?

16. Use the information given below to calculate the acceleration of the trolley.



Length of card = 5 cm

Time on clock 1 = 0.10 s (time taken for card to interrupt top light gate)
Time on clock 2 = 0.05 s (time taken for card to interrupt bottom light gate)
Time on clock 3 = 2.50 s (time taken for trolley to travel between top and bottom light gate)

17. A pupil uses light gates and a suitably interfaced computer to measure the acceleration of a trolley as it moves down an inclined plane.

The following results were obtained:

acceleration (ms^{-2}) 5.16, 5.24, 5.21, 5.19, 5.20, 5.20, 5.17, 5.19.

Calculate the mean value of the acceleration and the corresponding random uncertainty.

Graphs of Motion

18. Draw a graph of velocity against time using the figures in the table below. Use the graph to find the acceleration, the total distance travelled and the average velocity.

TIME (s)	0	1	2	3	4	5
VELOCITY (ms^{-1})	2.4	3.2	4.0	4.8	5.6	6.4

19. Draw a velocity – time graph and use it to draw an acceleration – time graph.

TIME (s)	0	1	2	3	4	5
VELOCITY (ms^{-1})	0	2	4	6	8	10

20. Use the information in the table below to draw a graph of velocity against time. From the graph find the distance traveled, the average velocity and draw an acceleration against time graph.

TIME (s)	0	1	2	3	4	5	6	7	8
VELOCITY (ms^{-1})	2.0	2.4	2.8	3.2	3.6	3.6	3.0	2.4	1.8

21. Draw a velocity – time graph for each of the set of figures below. From each draw an acceleration –time graph and a displacement – time graph.

	TIME (s)	0	1	2	3	4	5	6	7	8
(a)	VELOCITY (ms^{-1})	20	16	12	8	4	0			
(b)	VELOCITY (ms^{-1})	0	6	12	18	20	22	24		
(c)	VELOCITY (ms^{-1})	0	4	8	12	16	16	16	14	12

22. Draw velocity – time, distance - time and displacement – time graphs using the figures below.

TIME (s)	0	1	2	3	4	5	6	7	8
VELOCITY (ms^{-1})	12	10	8	6	4	2	0	-2	-4

23. A car accelerates from rest at 2.5 ms^{-2} for 6 s, continues to accelerate at 1.0 ms^{-2} for a further 5 s and finally travels at a steady speed for 4 s.

    Draw a speed – time graph of its motion and find the total distance travelled.

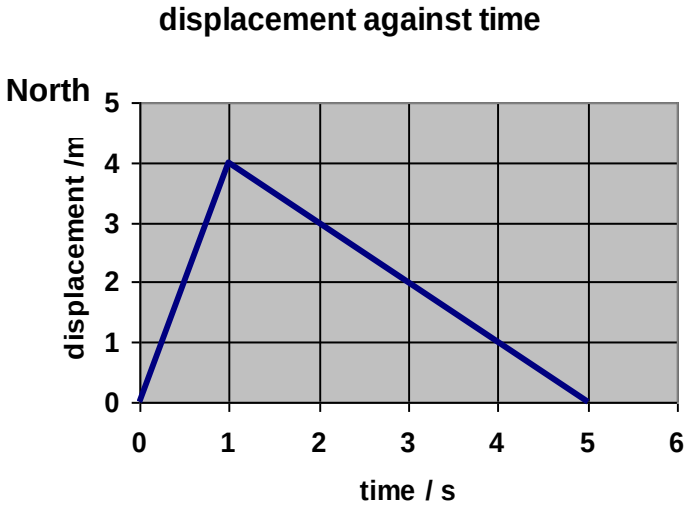
24. A car travelling at 30 ms^{-1} passes a stationary police car, which at the instant the speeding car passes, begins to accelerate in pursuit at 2.0 ms^{-2}. After 20 s the police car reaches a steady speed.

    Use a speed – time graph to find

    (a) how far behind the police car is after 30 s of the chase, and

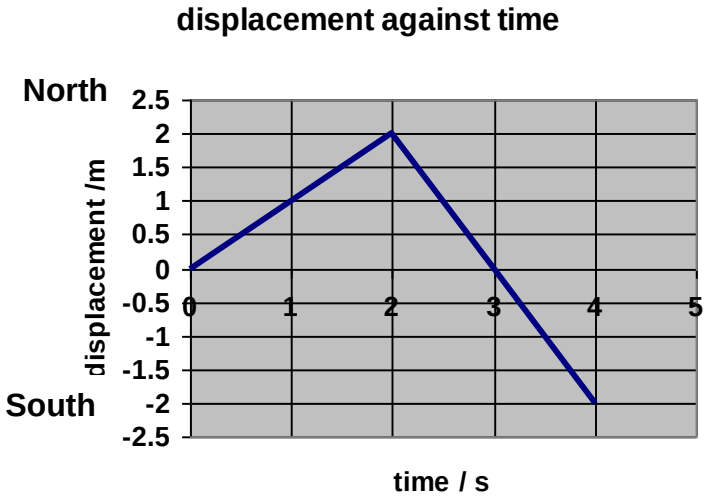
    (b) how long the police car takes to draw level with the speeding car.

25. The graph below shows how the displacement of an object varies with time.



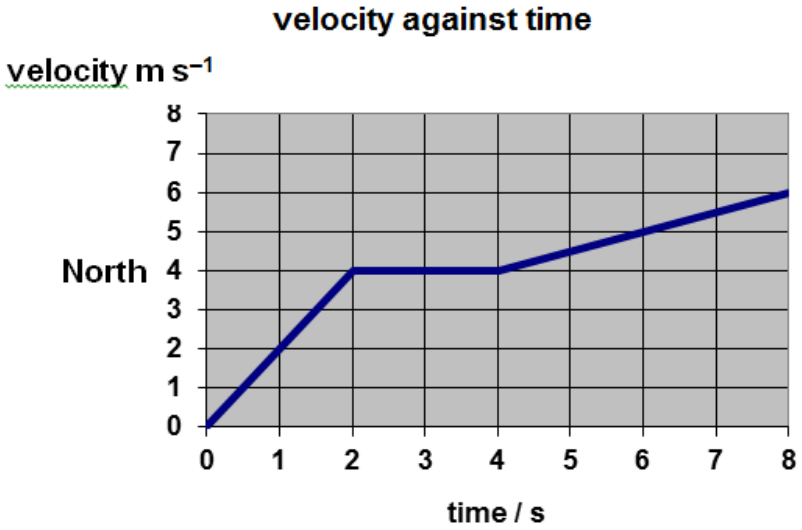
(a) Calculate the velocity of the object during the first second.
(b) Calculate the velocity of the object between 1 and 5 s.
(c) Draw the corresponding distance against time graph for this object.
(d) Calculate the average speed of the object for the 5 seconds.
(e) Draw the corresponding velocity against time graph for this object.
(f) What are the displacement and the velocity of the object 0.5 seconds after the start?
(g) What are the displacement and the velocity of the object 3 seconds after the start?

26. The graph below shows how the displacement of an object varies with time.



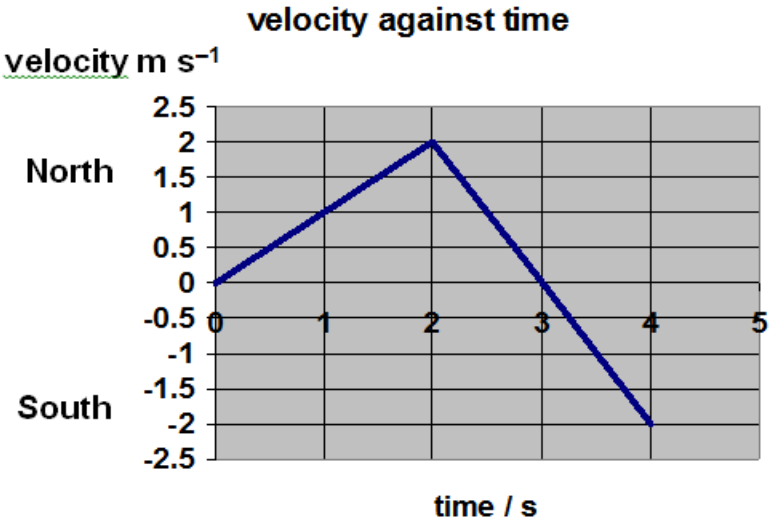
(a) Calculate the velocity of the object between 0 and 2 s.
(b) Calculate the velocity of the object between 2 and 4 s.
(c) Draw the corresponding distance against time graph for this object.
(d) Calculate the average speed of the object for the 4 seconds.
(e) Draw the corresponding velocity against time graph for this object.
(f) What are the displacement and the velocity of the object 0.5 seconds after the start?
(g) What are the displacement and the velocity of the object 3 seconds after the start?

27. The graph below shows how the velocity of an object varies with time.



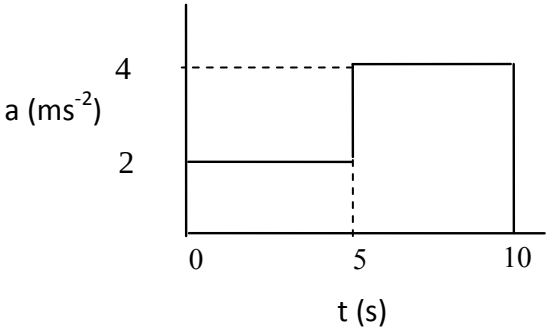
(a) Calculate the acceleration of the object between 0 and 1 s.
(b) What is the acceleration of the object between 2 and 4 s?
(c) Calculate the displacement of the object after 2 s.
(d) What is the displacement of the object after 8 seconds?
(e) Sketch the corresponding displacement against time graph for this object.

28. The graph below shows how the velocity of an object varies with time.



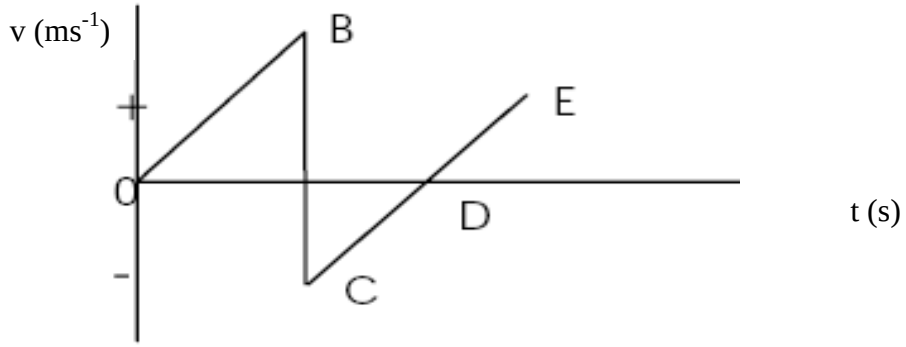
(a) Calculate the acceleration of the object between 0 and 2 s.
(b) What is the acceleration of the object between 2 and 4 s?
(c) Draw the corresponding acceleration against time graph for this object.
(d) What are the displacement and the velocity of the object after 3 s?
(e) What are the displacement and the velocity of the object after 4 s?
(f) Sketch the corresponding displacement against time graph for this object.

29. The graph shows how the acceleration (a) of an object, starting from rest, varies with time (t).



Draw a graph to show how the velocity of the object varies with time.

30. The graph below shows the velocity of a ball which is dropped and bounces on the floor. **Downwards** is taken as being **positive**.



(a) During section OB of the graph in which direction is the ball travelling ?

(b) What can you say about the speed of the ball during section OB ?

(c) What happens during section BC of the graph ?

(d) During section CD of the graph in which direction is the ball travelling ?

(e) What can you say about the speed of the ball during section CD ?

(f) During section DE of the graph in which direction is the ball travelling ?

(g) What can you say about the speed of the ball during section DE ?

(h) What happened to the ball at point B on the graph ?

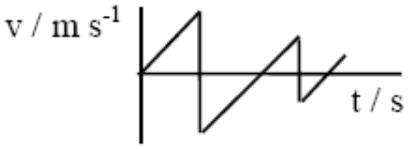
(i) What happened to the ball at point C on the graph ?

(j) What happened to the ball at point D on the graph ?

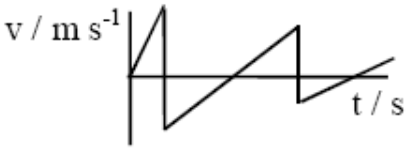
(k) How does the speed of the ball immediately after rebound compare with the speed immediately before ?

31. A ball is dropped from rest and bounces several times, losing some kinetic energy at each bounce. Select the correct velocity - time graph for this motion from the options below.

A

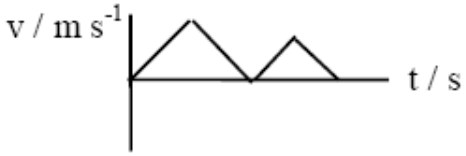


B



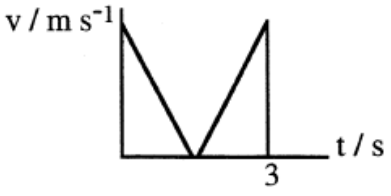
C

D

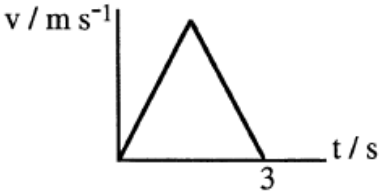


E

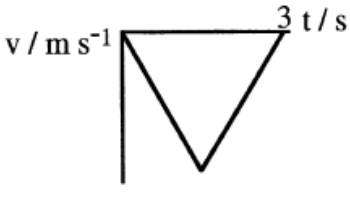
32. Which velocity - time graph below represents the motion of a ball which is thrown vertically upwards and returns to the thrower 3 seconds later?



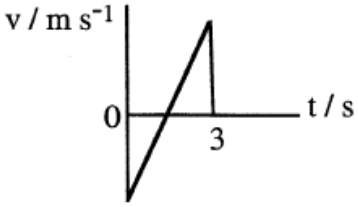
A



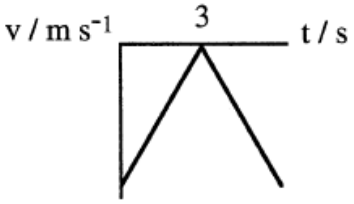
B



C



D



E

Equations of Motion

33. What was the initial velocity of a car if it reaches a velocity of 25 ms^{-1} after accelerating for 15 s at 0.8 ms^{-2} ?

34. What is the final velocity of a rocket which accelerates at 8.0 ms^{-2} for 40 s from an initial velocity of 240 ms^{-1} ?

35. How long will a train require to reduce its speed from 50 ms^{-1} to 20 ms^{-1} if the deceleration is 0.6 ms^{-2} ?

36. What is the acceleration of an object which is initially moving at 12 ms^{-1} in one direction and 60 s later is moving at 18 ms^{-1} in the opposite direction ?

37. How far does a vehicle travel if accelerating at 1.2 ms^{-2} from rest for 6.0 s ?

38. A car, initially moving at 20 ms^{-1}, accelerates at 0.4 ms^{-2} for 5.0 s. How far does it travel in this time?

39. A train decelerates at 0.25 ms^{-2} for 20 s. If its initial speed was 25 ms^{-1}, how far does it travel during braking ?

40. A vehicle starts from rest and accelerates for 16 s. If it travels 320 m, what was the value of the acceleration ?

41. What is the acceleration of a bullet which takes 50 ms to travel the length of an 80 cm gun barrel ?

42. A car which is initially travelling at 12 ms^{-1} accelerates for 8.0 s. If it travels a distance of 112 m during this time, what is its acceleration ?

43. How long does it take a vehicle, starting from rest, to travel a distance of 10.8 m if its acceleration is 2.4 ms^{-2} ?

44. What is the final velocity of a car which covers a distance of 64 m whilst accelerating at 0.5 ms^{-2} from an initial speed of 15 ms^{-1} ?

45. What is the acceleration of a trolley which travels a distance of 36 m whilst increasing its speed from 5 ms^{-1} to 13 ms^{-1} ?

46. How far does a car travel during braking from 32 ms^{-1} to 20 ms^{-1} if the deceleration is 2.4 ms^{-2} ?

47. A rocket sledge accelerates from 40 ms^{-1} to 100 ms^{-1} in 6.0 s. How far does it travel in this time ?