LONDON SCIENCE COLLEGE

Name:

Date:

GRAPHS FOR MOTION
TEST 2

AS-Level

Mark

Grade

PHYSICS

For this paper you must have:

- Ruler
- Pencil and Rubber
- Scientific calculator, which you are expected to use when appropriate

Instructions

- Answer all questions
- Answer questions in the space provided
- All working must be shown

Information

- The marks for the questions are shown in brackets

1 A supertanker of mass 4.0×10^8 kg, cruising at an initial speed of 4.5 m s^{-1}, takes one hour to come to rest.

(a) Assuming that the force slowing the tanker down is constant, calculate

(i) the deceleration of the tanker,

_____

_____

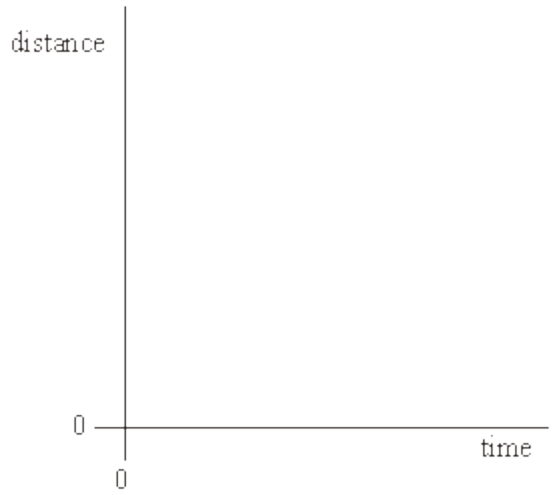
(ii) the distance travelled by the tanker while slowing to a stop.

_____

_____

(4)

(b) Sketch, using the axes below, a distance-time graph representing the motion of the tanker until it stops.



(2)

(c) Explain the shape of the graph you have sketched in part (b).

_____

_____

_____

_____

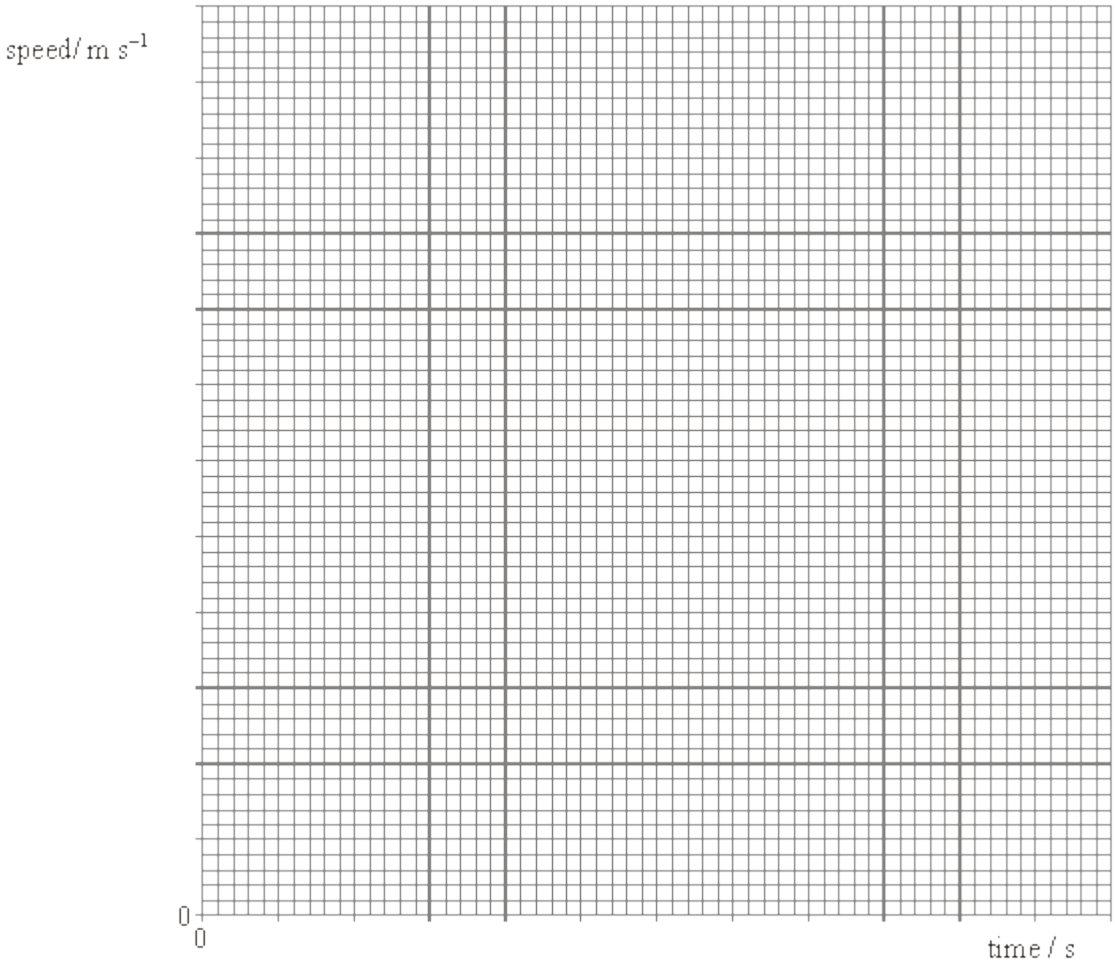
(2)

(Total 8 marks)

2 A car accelerates from rest to a speed of 26 m s^{-1}. The table shows how the speed of the car varies over the first 30 seconds of motion.

time/ s	0	5.0	10.0	15.0	20.0	25.0	30.0
speed/ m s^{-1}	0	16.5	22.5	24.5	25.5	26.0	26.0

(a) Draw a graph of speed against time on the grid provided.



(3)

(b) Calculate the average acceleration of the car over the first 25 s.

_____

_____

(2)

(c) Use your graph to estimate the distance travelled by the car in the first 25 s.

_____

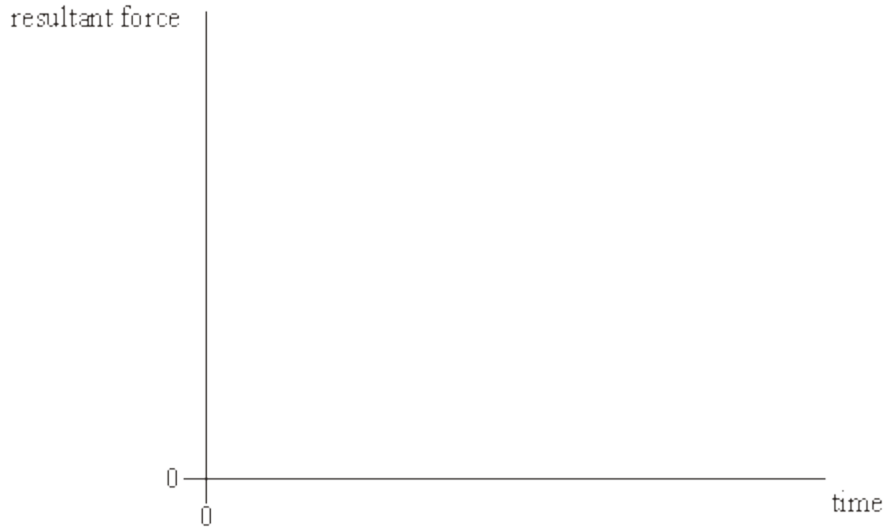
_____

_____

_____

(2)

(d) Using the axes below, sketch a graph to show how the resultant force acting on the car varies over the first 30 s of motion.



(2)

(e) Explain the shape of the graph you have sketched in part (d), with reference to the graph you plotted in part (a).

_____

_____

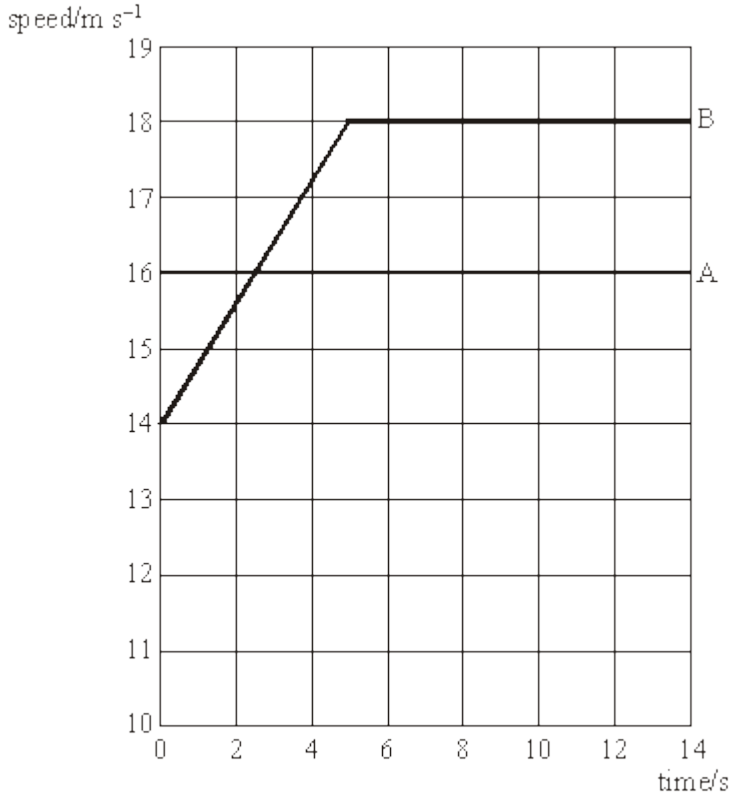
_____

_____

(2)

(Total 11 marks)

3 The graph represents the motion of two cars, A and B, as they move along a straight, horizontal road.



(a) Describe the motion of each car as shown on the graph.

(i) car A: _____

_____

(ii) car B: _____

_____

(3)

(b) Calculate the distance travelled by each car during the first 5.0 s.

(i) car A: _____

_____

_____

(ii) car B: _____

_____

_____

(4)

(c) At time t = 0, the two cars are level. Explain why car A is at its maximum distance ahead of B at t = 2.5 s

_____

_____

_____

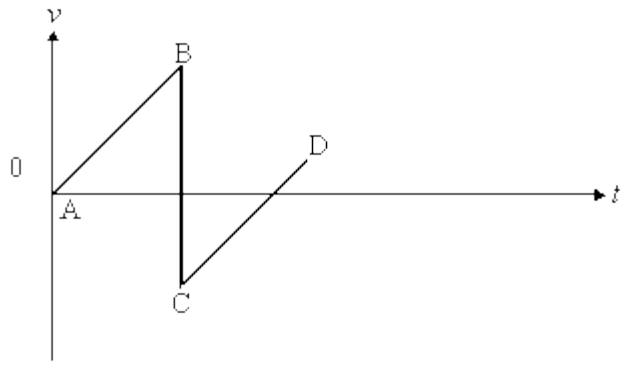
_____

_____

(3)

(Total 10 marks)

4 The diagram shows the velocity-time graph for a vertically bouncing ball, which is released above the ground at A and strikes the floor at B. The effects of air resistance have been neglected.



(a) (i) What does the gradient of a velocity-time graph represent?

_____

(ii) Explain why the gradient of the line CD is the same as line AB.

_____

_____

(iii) What does the area between the line AB and the time axis represent?

_____

(iv) State why the velocity at C is negative.

_____

_____

(v) State why the speed at C is less than the speed at B.

_____

_____

_____

(5)

(b) The ball has a mass of 0.15 kg and is dropped from an initial height of 1.2 m. After impact the ball rebounds to a height of 0.75 m.

Calculate

(i) the speed of the ball immediately before impact,

_____

_____

(ii) the speed of the ball immediately after impact,

_____

_____

(iii) the change in momentum of the ball as a result of the impact,

_____

_____

(iv) the magnitude of the resultant average force acting on the ball during impact if it is in contact with the floor for 0.10 s.

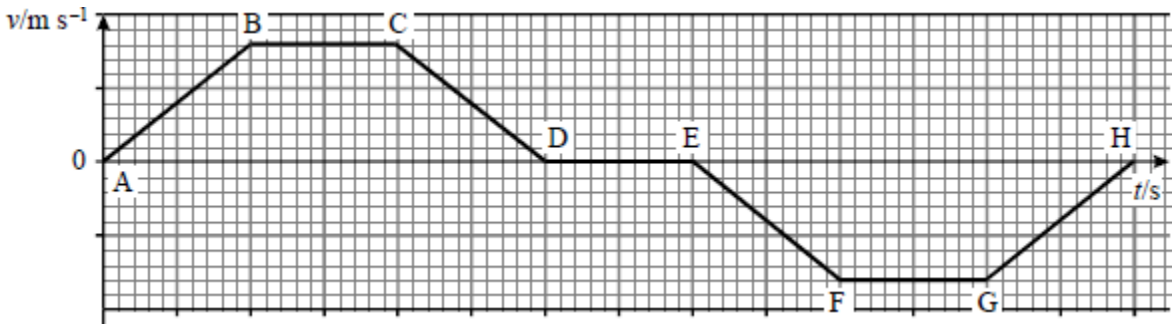
_____

_____

(8)

(Total 13 marks)

5 The graph below shows how the velocity of a toy train moving in a straight line varies over a period of time.



(a) Describe the motion of the train in the following regions of the graph.

AB _____

BC _____

CD _____

DE _____

EF _____

(5)

(b) What feature of the graph represents the displacement of the train?

_____

_____

(1)

(c) Explain, with reference to the graph, why the distance travelled by the train is different from its displacement.

_____

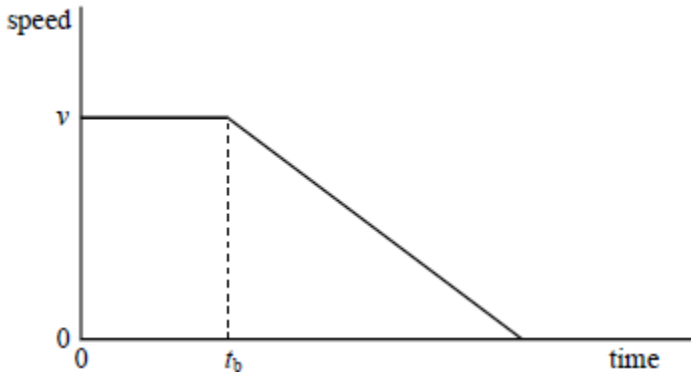
_____

_____

(2)

(Total 8 marks)

6 The driver of a car sees an obstruction ahead and applies the brakes at time t_b later, bringing the car to a halt. The graph shows how the speed of the car varies with time.



The stopping distance, s, of the car which was travelling at speed v before the driver applied the brakes, can be represented by the equation

$$s = t_b + \frac{v^2}{2a},$$

where α is the magnitude of the deceleration of the car (assumed constant).

(a) State what distance is represented by each of the terms

$vt >_{b}$ _____

$\frac{v^2}{2a}$ _____

(2)

(b) The table includes data on stopping distances of cars. Column C gives the total stopping distance for a car travelling at each of the speeds shown in column A.

column A	**column B**	**column C**	**column D**
speed v/km h^{-1}	speed v/m s^{-1}	stopping distance s/m	$\frac{s}{v}$/sec
32	8.9	12	
48		23	
64		36	
80		53	
96		73	
112		96	

(i) Complete column B,

(ii) In column D, calculate each of the corresponding values of $\frac{s}{v}$.

(2)

(c) The equation for s can be rearranged as $\frac{s}{v} = t_b + \frac{v}{2a}$.

From the data you have calculated, plot a suitable graph to verify this equation.

(One sheet of graph paper should be provided)

(5)

(d) From your graph determine the value of

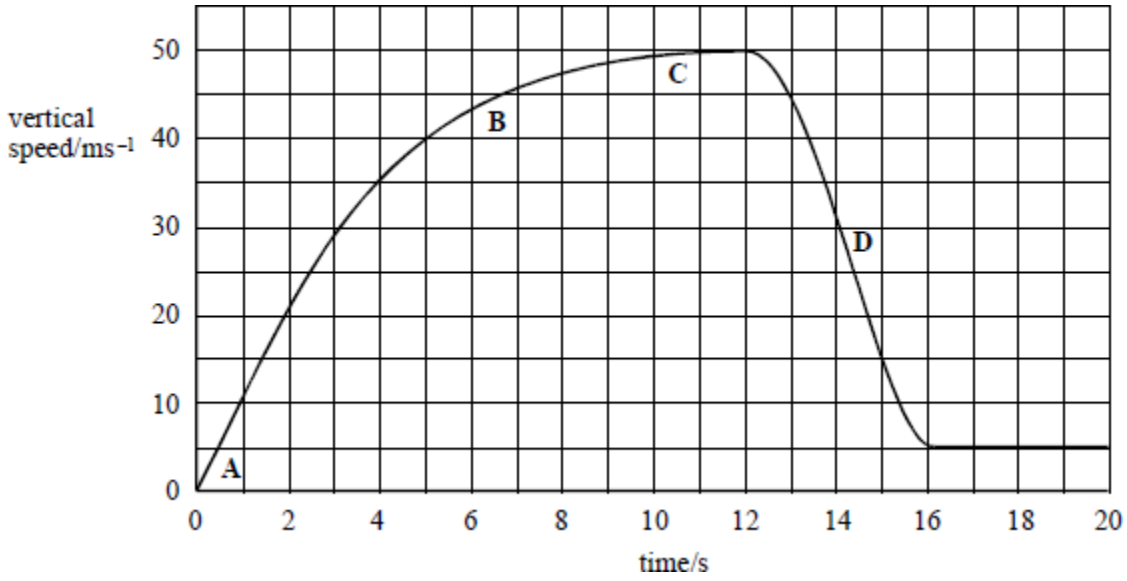
(i) t_b _____

(ii) the magnitude of the deceleration, a.

(4)

(Total 13 marks)

7 The graph shows how the vertical speed of a parachutist changes with time during the first 20 s of his jump. To avoid air turbulence caused by the aircraft, he waits a short time after jumping before pulling the cord to release his parachute.



(a) Regions A, B and C of the graph show the speed before the parachute has opened. With reference to the forces acting on the parachutist, explain why the graph has this shape in the region marked

(i) A,

(ii) B,

(iii) C, _____

_____

_____

_____

(6)

(b) Calculate the maximum deceleration of the parachutist in the region of the graph marked D, which shows how the speed changes just after the parachute has opened. Show your method clearly,

_____

_____

_____

(2)

(c) Use the graph to find the total vertical distance fallen by the parachutist in the first 10 s of the jump. Show your method clearly.

_____

_____

_____

_____

_____

(4)

(d) During his descent, the parachutist drifts sideways in the wind and hits the ground with a vertical speed of 5.0 m s^{-1} and a horizontal speed of 3.0 m s^{-1}. Find

(i) the resultant speed with which he hits the ground,

_____

_____

_____

(ii) the angle his resultant velocity makes with the vertical.

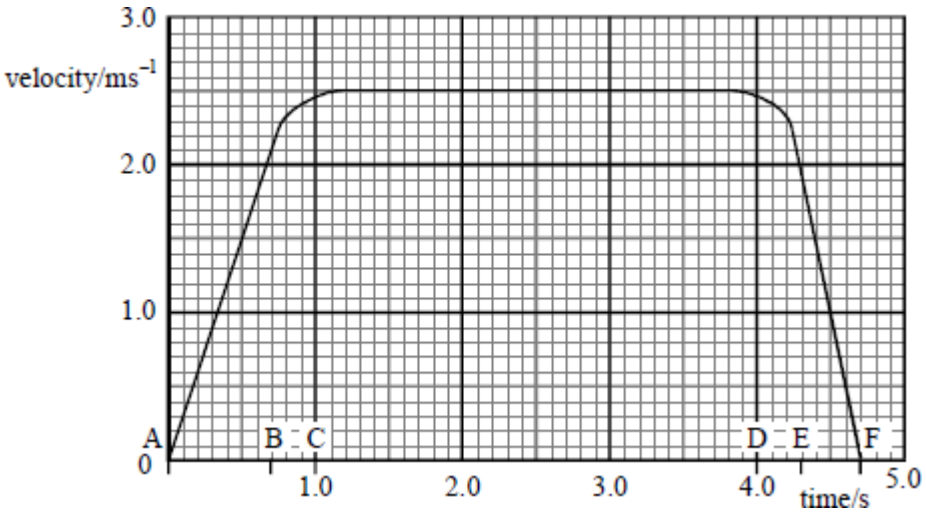
_____

_____

(2)

(Total 14 marks)

8 A mass of 1500 kg is attached to a cable and raised vertically by a crane. The graph shows how its velocity varies with time.



(a) Determine

(i) the initial uniform acceleration of the mass, _____

_____

_____

(ii) the distance travelled by the mass while it is accelerating upwards.

_____

_____

_____

(3)

(b) (i) Calculate the tension in the cable in the intervals

AB, _____

_____

_____

_____

CD _____

_____

(ii) State in which interval of the motion the tension in the cable is least.

_____

(4)

(c) Calculate the power supplied by the crane during the interval CD.

_____

_____

(2)

(Total 9 marks)

9 A ball is dropped and rebounds vertically to less than the original height.

For this first bounce only, sketch graphs of

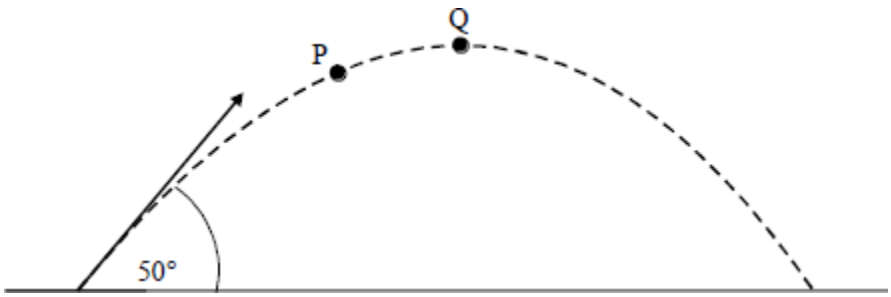
(a) the velocity of the ball plotted against time,

(4)

(b) the acceleration of the ball plotted against time.

(1)

(c)



The ball is then thrown at an angle to the horizontal and follows the trajectory shown in the diagram.

Mark on the diagram the directions of

(i) the acceleration vector at P,

(ii) the acceleration vector at Q,

(iii) the momentum vector at P,

(iv) the momentum vector at Q.

(4)

(d) The mass of the ball is 0.15 kg and the initial direction makes an angle of 50° to the horizontal. Calculate the magnitude of the momentum of the ball at Q when it is projected with an initial speed of 15 m s^{-1}. Neglect the effects of air resistance.

_____

_____

_____

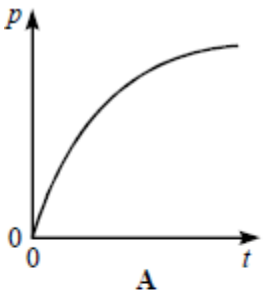
_____

(4)

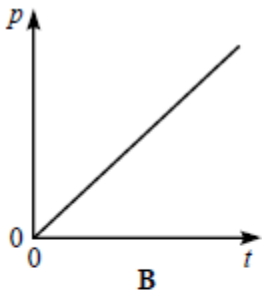
(Total 13 marks)

10 A body is accelerated from rest by a constant force.

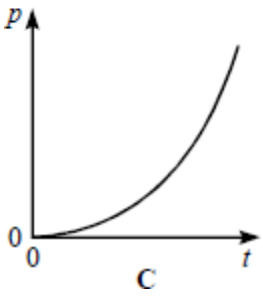
Which one of the following graphs best represents the variation of the body's momentum p with time t?



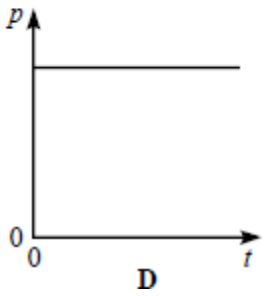
A



B



C



D

(Total 1 mark)