O Level Pure Physics Structured

Kinematics Test 1.0

Q1

Fig. 1.1 shows a 58 g ball being thrown vertically upwards from the top of a building with an initial velocity of 20 m/s. It reaches the highest point and begins to fall. It lands on the ground in the 6th second. The velocity-time graph is shown in Fig. 1.2.

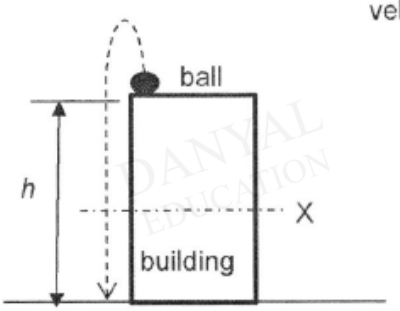

Fig. 1.1

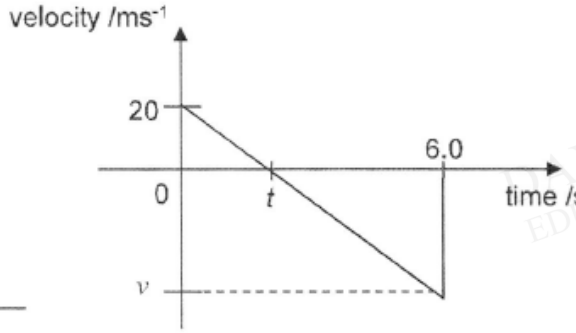

Fig. 1.2

(a) The acceleration due to gravity is 10 m/s². Calculate

(i) the time *t* for the ball to reach its highest point,

time = ... [2]

(ii) the velocity *v* of the ball just before it touches the ground.

velocity = ... [1]

(b) Determine the height *h* of the building.

height = ... [2]

(c) Explain how Fig. 1.2 shows that the stone is moving in opposite direction after a period of time.

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..... [1]

(d) State the assumption made in order to obtain the straight line graph in Fig. 1.2.

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..... [1]

Q2

Fig. 1.1 shows the vertical velocity of a skydiver from the moment he jumps off an aircraft during his skydiving trip.

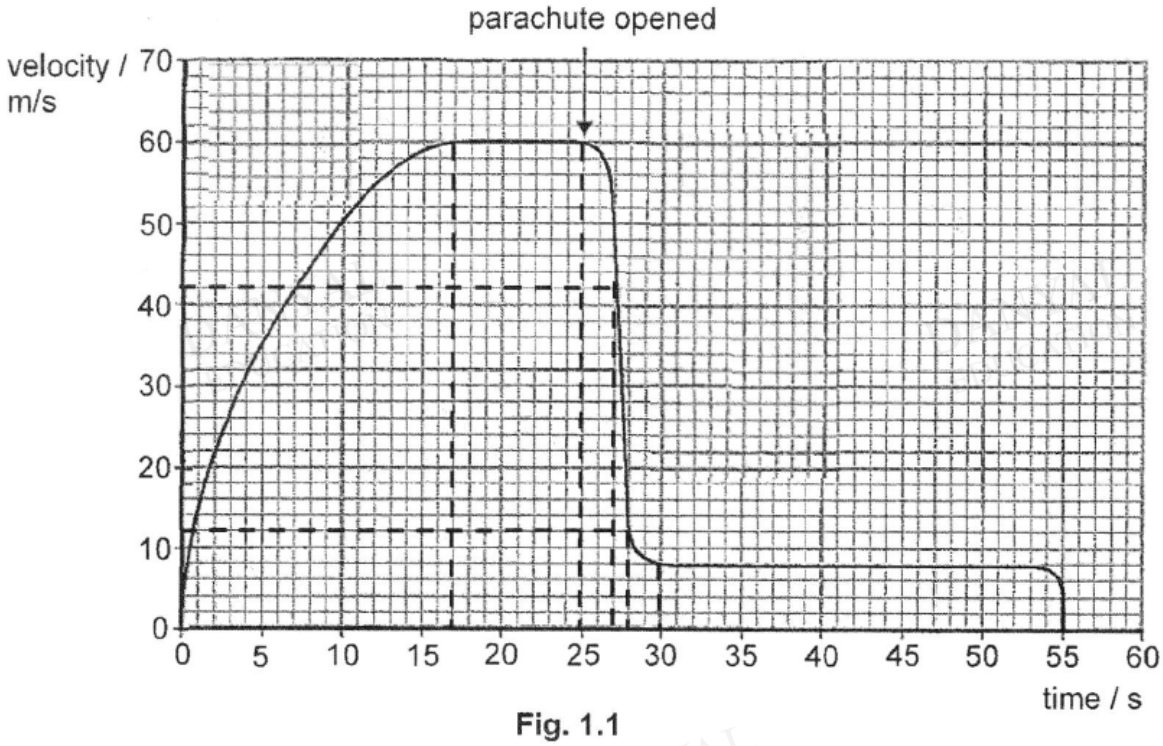

Fig. 1.1

Describe the motion of the skydiver during the first 30 s of his journey down.

[5]

Q3

Fig. 2.1 shows a man travelling on snow using a rocket pack.

Fig. 2.1

Initially, he is at rest and accelerates at a decreasing rate for 10 s. For the next 5.0 s, he travels at a uniform velocity of 8.0 m/s. His rocket pack malfunctions and he decelerates at a decreasing rate for the last 10 s till he comes to a rest.

(a) In the space below, sketch the velocity-time graph of the man.

[2]

(b) Calculate the distance travelled by the man when his velocity is uniform.

distance = _____ [1]

(c) Explain, in terms of the forces acting, why the acceleration changes for the entire 25 s of his motion.

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..... [3]

(d) The man bends down while he is in motion as shown in Fig. 2.1. He wants to reduce air resistance so he can have a greater acceleration. Explain another possible reason for doing so.

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..... [1]

Q4

Fig. 1.1 shows the horizontal forces acting on a car moving on a straight level road. You may assume that the friction between the car and the road is constant.

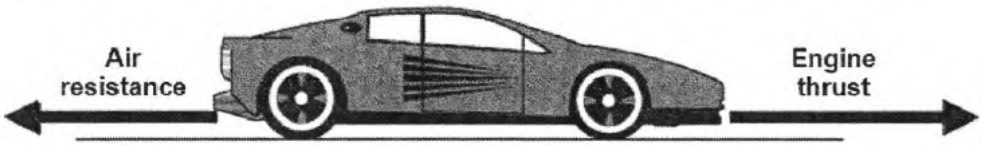

Fig. 1.1

Fig. 1.2 shows the speed-time graph for the first 24 s of the motion of the car along the straight level road.

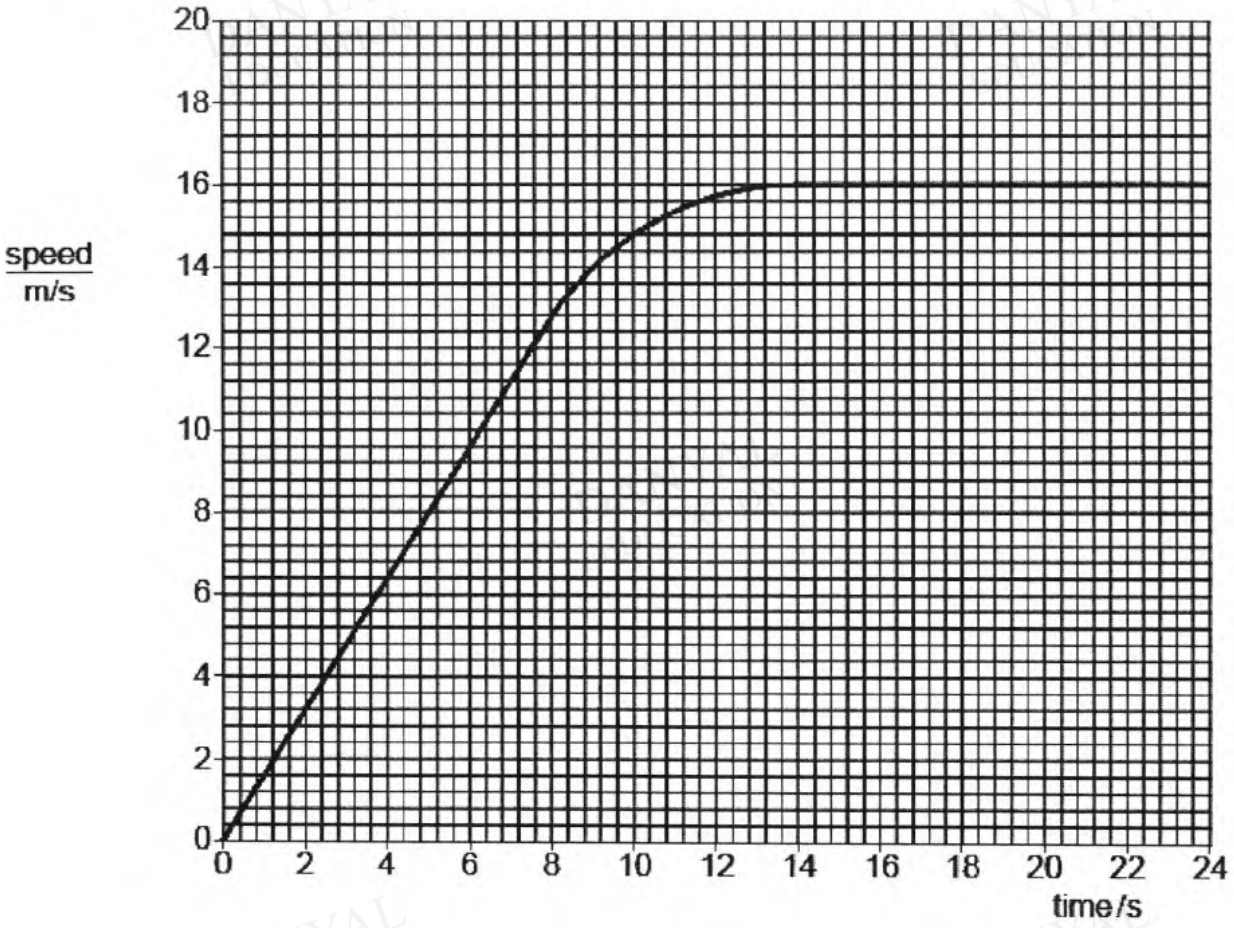

Fig. 1.2

(a) Determine the acceleration of the car during the first 8 s.

acceleration = ... [1]

(b) Determine the distance travelled by the car in the first 6 s.

distance travelled = ... [1]

(c) Use Newton's laws to explain why the acceleration of the car decreases to zero eventually.

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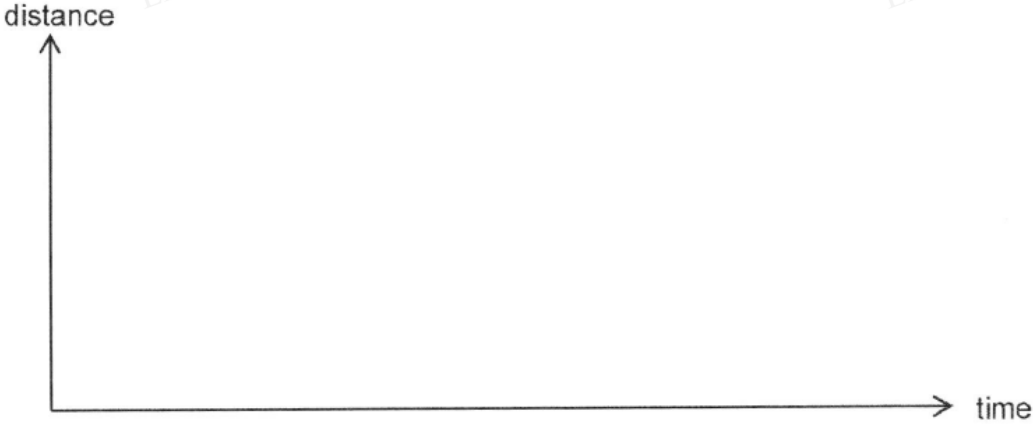
..... [3]

(d) In the axes below, sketch the distance-time graph of the car for the first 24 s.
You do not need to give any details on both axes. [2]



Q5

11. In **Fig. 11.1**, a stunt man, initially at rest at position 1, has with one end of a thick elastic cord attached to him and the other end of the cord is firmly attached to a point on a high bridge.

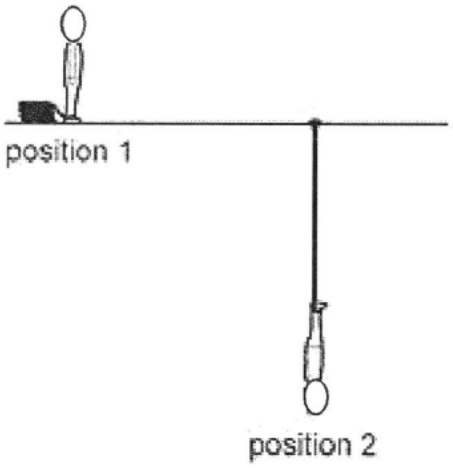


Fig 11.1

When the man jumps from the bridge, he falls freely under gravity for 2.5 s till he reaches position 2 in **Fig. 11.1**. Take acceleration of free fall to be 10 ms^{-2}.

a) Calculate the vertical speed the man acquires at the end of his free fall. [2]

Speed = ...

b) Sketch a velocity-time graph for the vertical motion of the man during his free fall. [2]
Indicate clearly the velocity and time on the axes.

c) Calculate the vertical distance fallen during his free fall. [2]

Distance = ……..

d) Suggest and explain whether the stunt man reaches terminal velocity before the cord stretches. [2]

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e) The stunt man is replaced with another person that has similar body surface area but a smaller mass. [2]

Taking into consideration air resistance and assuming both men reach terminal velocity, compare and explain the difference in the terminal velocity of the two men.

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Answers

Kinematics Test 1.0

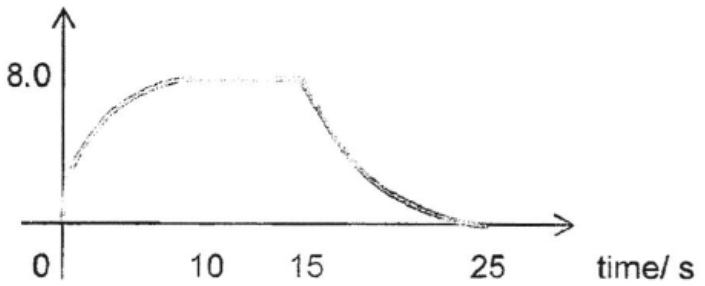
Q1

ai	a = (v – u) / t -10 = (0-20) / t [M1] t = 2.0 s [A1]
aii	-10 = (v-0) / (6.0-2.0) -10 = v / 4.0 v = - 40 m/s [A1] (2 sig.fig. & allow for e.c.f.)
b	height = area under the graph from 4.0s to 6.0s = ½ x (6.0 – 4.0) x (20 + 40) [M1] = 60 m [A1] (allow for ecf)
d	After 2.0 s, the velocity changes from positive to negative. [B1]
e	No air resistance acting on the ball throughout the motion. [B1]

Q2

From 0 s to 17 s, the skydiver has a decreasing acceleration.	[1]
He moves at a constant velocity of 60 m/s from 17 s to 25 s.	[1]
From 25 s to 27 s, he experiences an increasing deceleration.	[1]
In the next 1 s, he has a uniform deceleration of 30 m/s^2.	[1]
From 28 s to 30 s, he experiences a decreasing deceleration.	[1]

Q3

a	velocity/ ms^{-1}  	1 m: shape; 1 m: x and y values
b	distance = 8 × 5 = 40 m	1
c	• Initial 10 s: F_{net} = uniform forward force – increasing air resistance = ma Therefore net force is decreasing. • Next 5 s: uniform forward force = air resistance. Net force is zero. • Last 10 s: 0 – decreasing air resistance = ma Therefore net force is negative and decreasing	1 1 1
d	Increase stability due to lower centre of gravity OR To ensure that the force exerted by the rocket pack has a larger horizontal component so that the push force is greater	1

Q4

(a)	When t = 8s, v = 12.8 m/s acceleration = gradient of v-t graph = (12.8 – 0) / (8 – 0) = **1.6 m/s²**	[1]: W, C/F, A & U
(b)	When t = 6s, v = 9.6 m/s Distance = area under v-t graph (1st 6 s) = ½(6)(9.6) = **28.8 m**	[1]: W, C/F, A & U
(c)	• Constant engine thrust & increasing air resistance leads to • decreasing net force acting on car (and acceleration decreases). • Eventually, engine thrust and air resistance are equal in magnitude and opposite in direction / balanced, leads to zero net force (and zero acceleration)	[1] [1] [1]
(d)	• Curve of positive increasing gradient • Straight line of positive gradient	[1] [1]

Q5

11a)	10 = (v-0)/2.5 v = 25 m/s	M1 A1
b)	Labelled axes with correct values Linear graph passing through the origin	A1 A1
c)	Distance = 0.5 (25) (2.5) Distance = 31.25 = 31.3 m	M1 A1

d)	No. There is no air resistance in free fall. The only force acting on the body is the weight. The body will never reach terminal velocity.	A1 A1
e)	The man with the smaller mass has a lower terminal velocity. The man with smaller mass has a smaller weight, thus the amount of resistive force required to balance the weight is smaller.	A1 A1