Name: _____ Class: _____ Date: _____

Sec 3 Physics

Worksheet 7: Vectors & 1-D Kinematics

SECTION A: CONCEPTUAL QUESTIONS

1. Does a car speedometer measure speed, velocity or both?

2. Can an object have a varying speed if its velocity is constant? If yes, give examples.

3. When an object moves with constant velocity, does its average velocity during any time interval differ from its instantaneous velocity at any instant?

4. If object A has a greater speed than object B, does object A necessarily have a greater acceleration?

5. As a freely falling object speeds up, what is happening to its acceleration due to gravity – does it increase, decrease or stay the same?

6. Can an object have zero velocity and non-zero acceleration at the same time? Give examples.

7. Can an object have zero acceleration and non-zero velocity at the same time? Give examples.

8. *Describe in words, the motion plotted in Figure 1 in terms of v, a etc. [Hint: try to think about the slope of the graph and how the slope varies with time.]

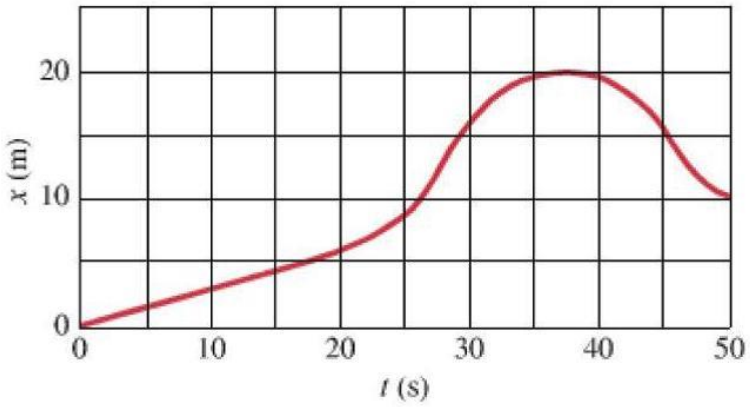


Figure 1

9. **Describe in words, the motion of the object graphed in Figure 2.

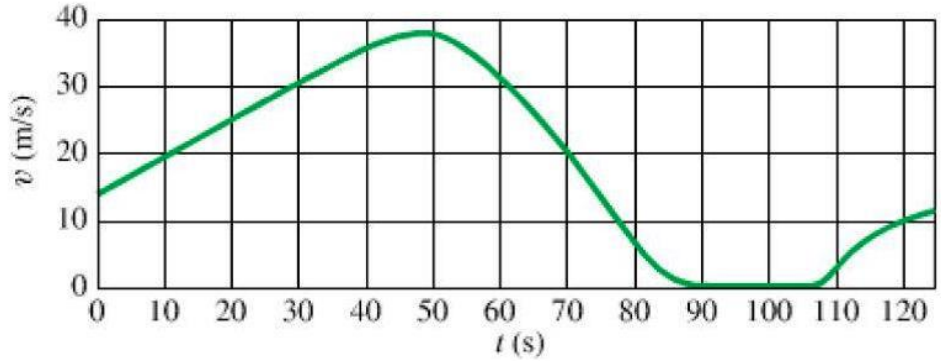


Figure 2

10. Sometimes, a word used in layman's speech can be different when it is used in a Physics context. Explain how the words *inertia* and *acceleration* can mean differently when used in Physics and in layman's speech.

SECTION B: STRUCTURED QUESTIONS

1 An airplane travels 3100 km at a speed of 790 km h^{-1}, and then encounters a tailwind that boosts its speed to 990 km h^{-1} for the next 2800 km.

a What was the total time for the trip?

b What was the average speed of the airplane for the trip?

2 *A car travelling 88 km h^{-1} is 110 m behind a truck travelling 75 km h^{-1}. How long will it take the car to reach the truck?

3 ** A bowling ball travelling with a constant speed hits the pins at the end of a bowling lane 16.5 m long. The bowler hears the sound of the ball hitting the pins 2.50 s after the ball is released from his hands. What is the speed of the ball? The speed of sound is 340 m s^{-1}.

4 *At highway speeds, a particular automobile is capable of an acceleration of about 1.6 m s^{-2}. At this rate, how long does it take to accelerate from 80 km h^{-1} to 110 km h^{-1}?

5 A car accelerates from 13 m s^{-1} to 25 m s^{-1} in 6.0 s. Assume constant acceleration.

a What was its acceleration?

b How far did it travel in this time?

6 A car travelling 85 km h^{-1} strikes a tree. The front end of the car compresses and the driver comes to rest after travelling 0.80 m. What was the average acceleration of the driver during the collision? Express the answer in terms of "*g*'s" where 1.00 *g* = 9.81 m s^{-2}.

7 ** A falling stone takes 0.28 s to travel past a window 2.2 m tall (see Figure 3). From what height above the top of the window did the stone fall?

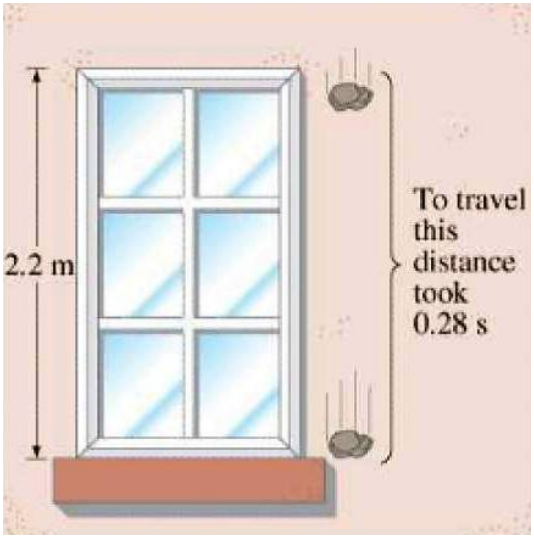
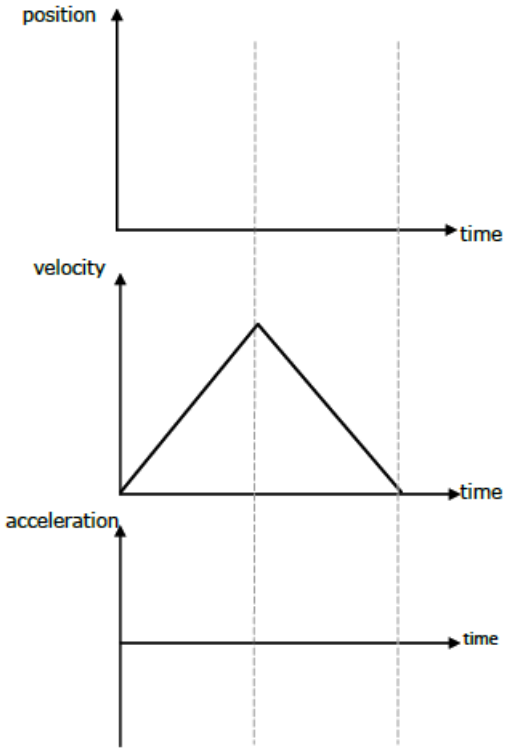


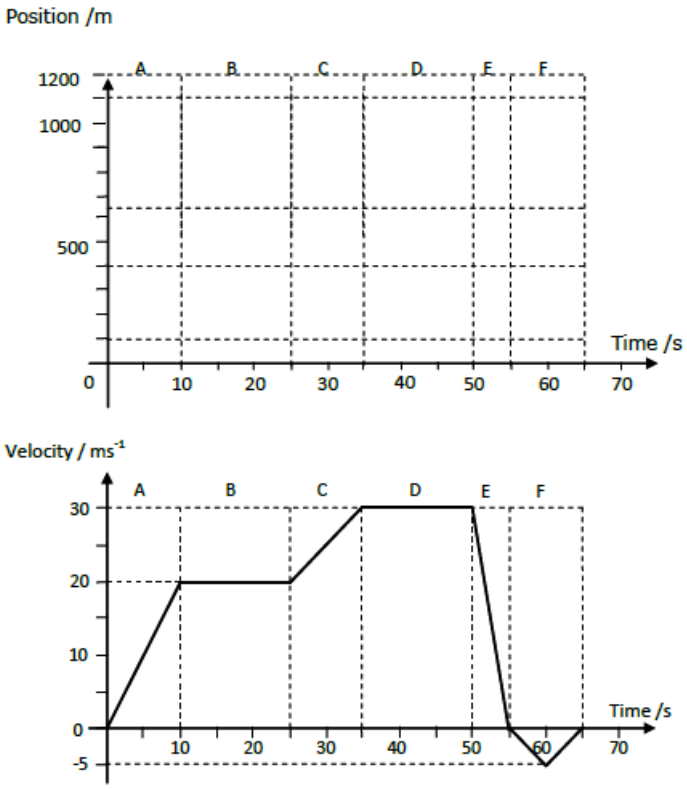
Figure 3

8 A car starts moving as the traffic light turns green. The road it is on is relatively horizontal and straight. The velocity of a car varies with time as shown in the figure below.

Sketch the corresponding acceleration-time and position-time graphs.



9 The figure shows a velocity-time graph for a journey lasting 65 s that **starts from the origin**. Sketch the corresponding acceleration-time and position-time graphs. Label the axes with the corresponding values.



10 Figure A shows the $v - t$ graph of an object starting from rest at the $x = 0$. Sketch the corresponding $x - t$ and $a - t$ graphs.

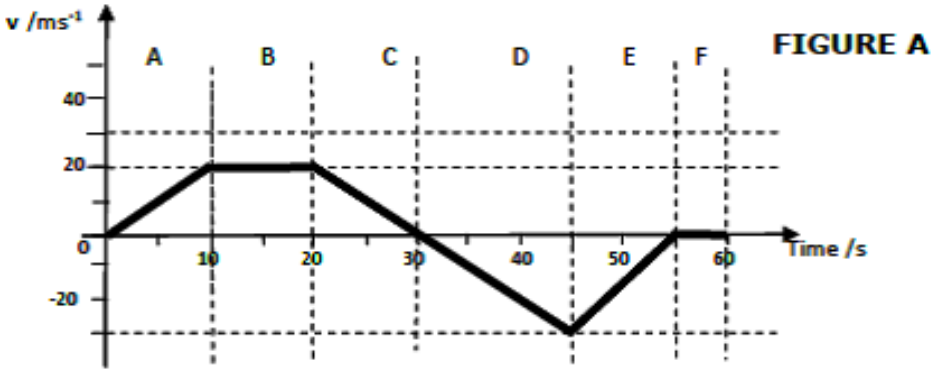


FIGURE A

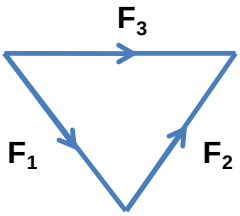
Describe the motion for section C to F.

11 庄周梦蝶

One afternoon Chuang Tzu awoke after dreaming that he was a butterfly. He wondered if he was really a butterfly dreaming of being a person. Let's suppose he dreamt this: Chuang Tzu was an exceptionally fast and agile butterfly. One day, he looked up and saw an anvil poised 2.00 m above his head. Just as the anvil began to fall, Chuang Tzu flew up toward it at 20.0 m s^{-1} (a very fast butterfly). When he reached the anvil, he instantly changed direction and flew toward the ground at the same speed. Upon reaching the ground, he instantly changed direction and flew toward the anvil,…, and so forth, until he awoke just as the dream anvil crushed the dream butterfly. How far did he fly?

12 Past Olympiad Question

$\mathbf{F_1}$, $\mathbf{F_2}$ and $\mathbf{F_3}$ are three separate forces acting on an object. The magnitude and direction of the forces are shown below. Which of the following answers correctly describe the resultant force?



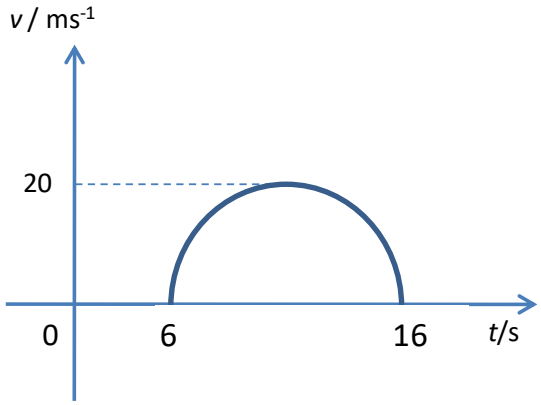
A zero

B $\mathbf{F_2}$

C $\mathbf{F_3}$

D $2\mathbf{F_3}$

13 What is the displacement of the object between 6 and 16 seconds according to the velocity - time graph below? You may assume that the curvature is circular. [Give answers to 3 s.f.]



14 A cliff diver is in the air for 2.00 s before hitting the water. Calculate the following quantities for his dive:

a The height from which he fell.

b His average velocity over the entire dive.

c His average velocity over the last half second.

15 A train moves along a horizontal track with a constant speed of 20.0 m s^{-1}. A passenger drops a ball from the ceiling, which is 2.50 m above the floor of the train.

a According to the passenger, how long does it take for the ball to reach the floor?

b According to passenger, where does the ball hit the floor?

c According to someone standing by the tracks, how far does the train move while the ball is in the air?

d What horizontal distance does a person on the track see the ball move while it falls?

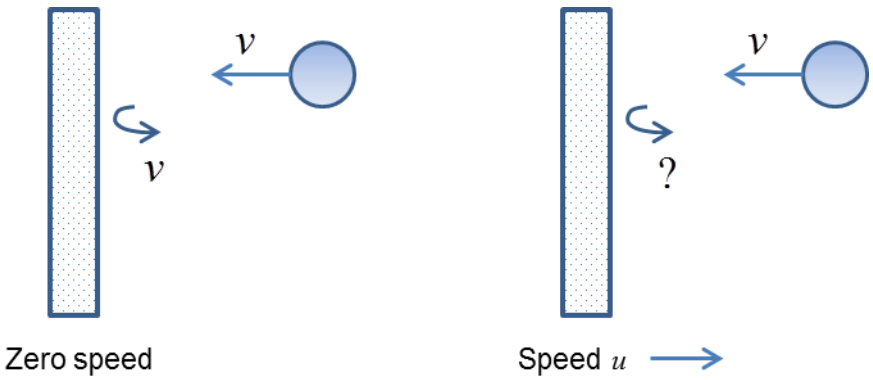
16 Suppose you are speeding along at 120 km h^{-1} on a highway and pass a Ferrari parked at a roadside restaurant. Twenty minutes later, the Ferrari leaves the restaurant and follows you at 150 km h^{-1}.

a How fast is the Ferrari moving relative to you?

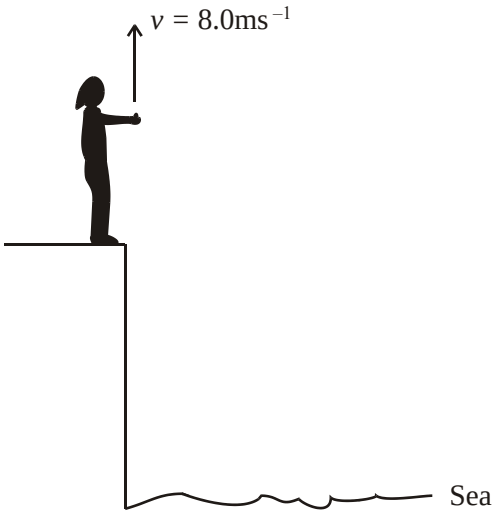
b How fast are you moving relative to the Ferrari?

c How long does it take for the Ferrari to catch up with you?

17 A ball of speed v strikes a massive, stationary wall at normal incidence, and rebounds with a final speed v in the opposite direction. This is an example of an elastic collision. In a second situation, the only change is that is also moving with speed u towards the ball. If the ball's initial speed is again v directed normally to the wall, and it rebounds elastically from the moving wall, what is the ball's final speed?



18 This question is about throwing a stone from a cliff.
Antonia stands at the edge of a vertical cliff and throws a stone vertically upwards.



The stone leaves Antonia's hand with a speed v = 8.0 m s^{-1}.

The acceleration of free fall g is 10 m s^{-2} and all distance measurements are taken from the point where the stone leaves Antonia's hand.

a Ignoring air resistance calculate

(i) the maximum height reached by the stone.

(ii) the time taken by the stone to reach its maximum height.

The time between the stone leaving Antonia's hand and hitting the sea is 3.0 s.

b Determine the height of the cliff.

19 **a** Define the term acceleration.

b An object has an initial speed u and an acceleration a. After time t, its speed is v and it has moved through a distance s.

The motion of the object may be summarized by the equations

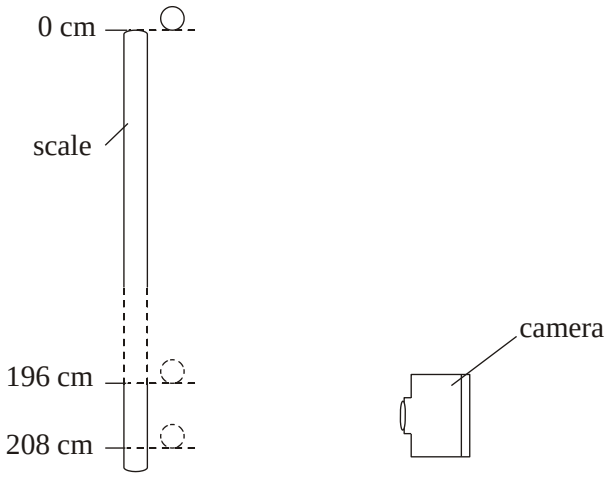
$$v = u + at$$

$$s = \frac{1}{2}(u + v)t$$

(i) State the assumption made in these equations about the acceleration a.

(ii) Derive, using these equations, an expression for v in terms of u, s and a.

c The shutter speed of a camera is the time that the film is exposed to light. In order to determine the shutter speed of a camera, a metal ball is held at rest at the zero mark of a vertical scale, as shown below. The ball is released. The shutter of a camera is opened as the ball falls.



The photograph of the ball shows that the shutter opened as the ball reached the 196 cm mark on the scale and closed as it reached the 208 cm mark. Air resistance is negligible and the acceleration of free fall is 9.81 m s^{-2}.

(i) Calculate the time for the ball to fall from rest to the 196 cm mark.

(ii) Determine the time for which the shutter was open. That is, the time for the ball to fall from the 196 cm mark to the 208 cm mark.

NUMERICAL ANSWERS TO SECTION B

1a	6.8 h	**1b**	874 km h^{-1}	**2**	30.5 s	**3**	6.73 m s^{-1}	**4**	5.2s
5a	2.0 m s^{-1}	**5b**	114 m	**6**	36 *g*'s	**7**	2.1 m	**11**	12.8 m
13	157 m	**14a**	19.6 m	**14b**	9.81 m s^{-2}	**14c**	17.2 m s^{-1}	**15a**	0.714 s
15c	14.3 m	**15d**	14.3 m	**16a**	30 km h^{-1}	**16b**	30 km h^{-1}	**16c**	1.3 h
17	$v + 2u$	**18a(i)**	3.2 m	**18a (ii)**	0.80 s	**18b**	21 m	**19c (i)**	0.632 s
19c (ii)	0.651 s								