Name..............................

Area of study 1 – Motion

Questions 1 to 5 relate to the following information.

Sally was driving her car at a constant speed of 54 km/h along a straight stretch of road. The total mass of the car and driver is 1600 kg.

Question 1

Use an appropriate calculation to show that Sally's car was moving at a constant speed of 15 ms^{-1}.

(1 mark)

Questions 2 to 5 relate to the following additional information.

Sally saw a traffic light in front of her change from green to red. It took her 1.2 seconds to see the light change and make the decision to apply her brakes in order to stop the car.

Question 2

What distance did the car travel before Sally applied the brakes?

m

(1 mark)

Question 3

Once Sally applied the brakes it took the car 4.4 seconds to come to a stop. Assuming the deceleration is constant, what was the size of the car's deceleration?

ms^{-2}

(2 marks)

Question 4

If Sally's car came to a stop next to the traffic light, how far from it had she been when she first saw it change from green to red?

m

(2 marks)

Question 5

How much work was done by the car's brakes in bringing the car to a stop?

kJ

(2 marks)

Questions 6 to 9 relate to the following information.
The graph in ***Figure 1*** shows part of a journey taken by a student on a tram. The tram and its passengers have a combined mass of 32 000 kg.

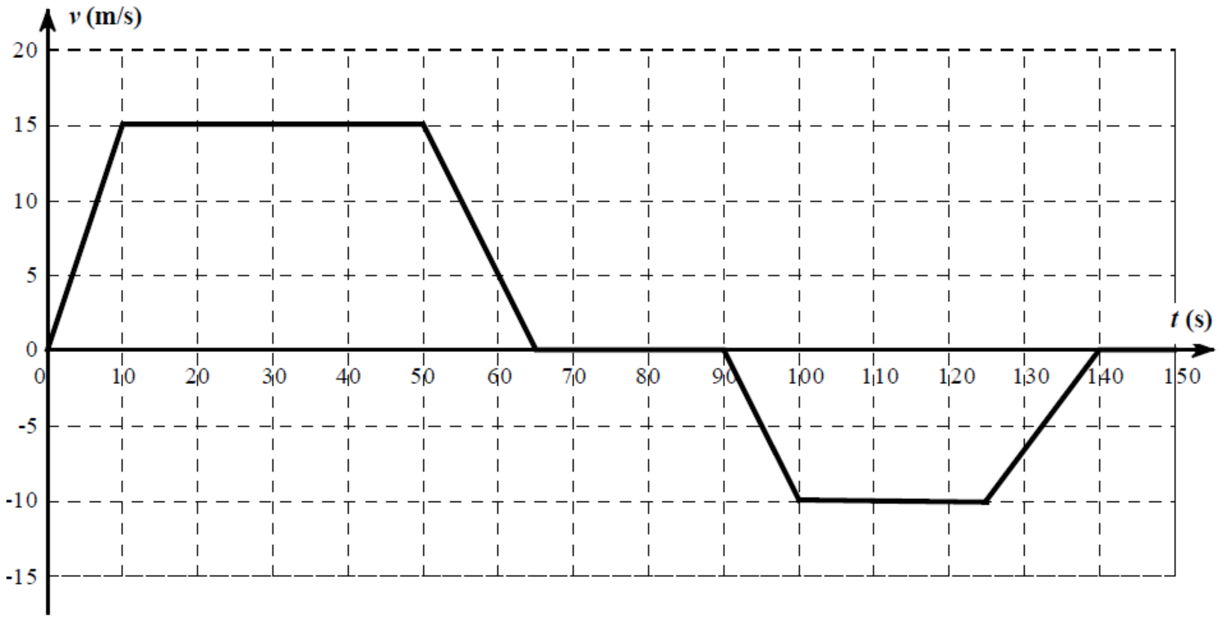


Figure 1

Question 6
What was the tram's acceleration at $t = 60$ seconds?

m/s^2
(2 marks)

Question 7
What was the resultant force acting on the tram at $t = 110$ seconds? Explain your answer.

N
(2 marks)

Question 8

If the driving force provided by the tram's motors during the first 10 seconds of the journey was a constant 61.3 kN, what average resistive force acted against the tram during this time?

N

(4 marks)

Question 9

What was the tram's average velocity for the 150-second journey as shown by the graph in ***Figure 1***?

ms^{-1}

(3 marks)

Questions 10 to16 relate to the following information.

A super-ball of mass 65.0 g was dropped from a height of 1.50 m onto the floor. ***Figure 2*** shows the super-ball just before it hits the floor (a), whilst it is momentarily stationary (b) and just after it rebounds from the floor (c). Ignore the effects of air resistance.

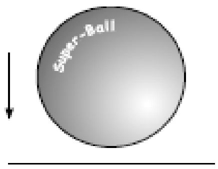


Figure 2a

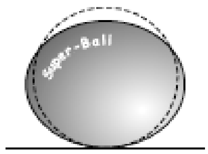


Figure 2b

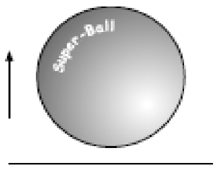
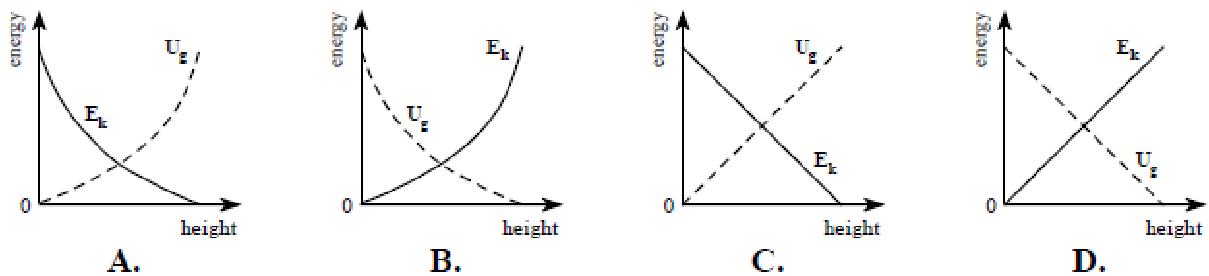


Figure 2c

Question 10

Which of the graphs, **A–E**, correctly shows the change in the super-ball's kinetic energy, E_k, and gravitational potential energy, U_g, with respect to height during the downwards part of its motion until just before it hits the floor?



(1 mark)

Question 11

With what speed will the super-ball hit the floor?

ms^{-1}

(2 marks)

Question 12

What is the direction of the super-ball's acceleration at the instant it is stationary as shown in ***Figure 2b***? Explain your answer.

(2 marks)

Question 13

On ***Figure 2b***, at their **points of application**, draw arrows that show the **two individual** forces acting on the super-ball at this instant. ***Label each arrow*** with the name of the force and indicate the **relative magnitudes** of the forces by the length of the arrows you draw.

(3 marks)

Question 14

Calculate the super-ball's change in velocity if it rebounds from the floor with a speed of 5.05 ms^{-1}.

(2 marks)

Question 15

If the super-ball was in contact with the floor for 40 ms, calculate the size of the average force exerted on the super-ball by the floor.

N

(2 marks)

Question 16

What was the super-ball's 'loss' in kinetic energy due to its collision with the floor? What happened to the 'missing' energy?

J

(2 marks)

Question 17 a. Convert 60 km h^{-1} into metres per second. (1)

A 1.7 m s^{-1}

B 17 m s^{-1}

C 216 m s^{-1}

D 21.6 m s^{-1}

b. A super-bouncy ball hits a wall with a velocity of 7.0 m s^{-1} east and rebounds with a velocity of 6.0 m s^{-1} west. Determine the change in velocity of the ball. (1)

A 1 m s^{-1} west

B 13 m s^{-1} east

C 13 m s^{-1} west

D 1 m s^{-1} east

Question 18

a. In a road test, a car was uniformly accelerated from rest over a distance of 400 m in 19.0 s. The driver then applied the brakes, stopping the car in 5.1 s with constant deceleration.

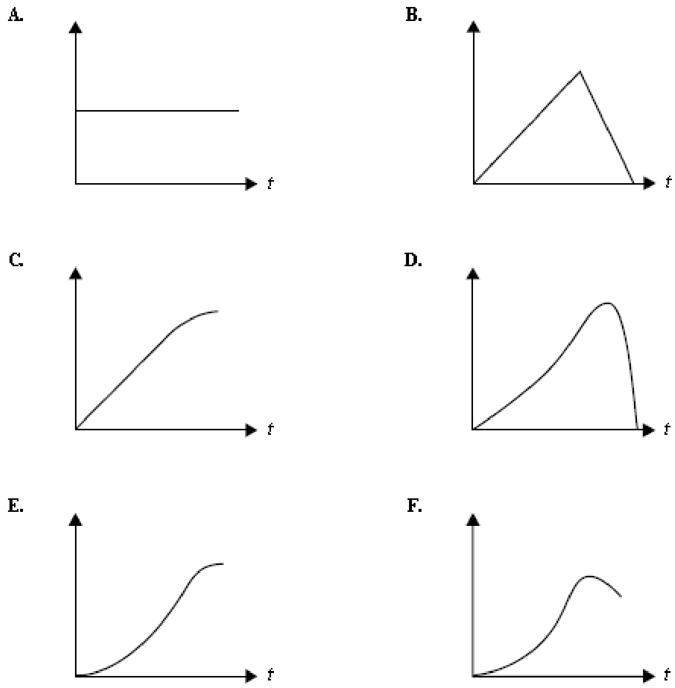
Calculate the acceleration of the car for the first 400 m.

(2 marks)

b. Calculate the average speed of the car for the entire journey, covering both the acceleration and braking sections. (Hint consider the velocity-time graph)

(3 marks)

The graphs (**A – F**) in the key below should be used when answering the two questions below. The horizontal axis represents time and the vertical axis could be velocity or distance.



c. Which of the graphs (**A – F**) best represents the velocity–time graph of the car for the entire journey?

(1 mark)

d. Which of the graphs (**A – F**) best represents the distance–time graph of the car for the entire journey?

(1 mark)

A stone dropped from rest down a mine shaft takes 3 seconds to reach the bottom. Neglect air resistance when determining the answers to questions **19 & 20**. **SHOW YOUR WORKING**

Question 19. What is the depth of the mine shaft?

a) 90 m **b)** 45 m **c)** 30 m **d)** 15 m

(2 marks)

Question 20

What is the magnitude of the velocity of the stone at the instant before striking the bottom?

a) 90 m/s **b)** 45 m/s **c)** 30 m/s **d)** 15 m/s

A truck of mass 30 tonnes drives across the bridge as shown in **Figure 4**. At the instant shown the truck's centre of mass is 30 m from end *A* and 10 m from end *B*.

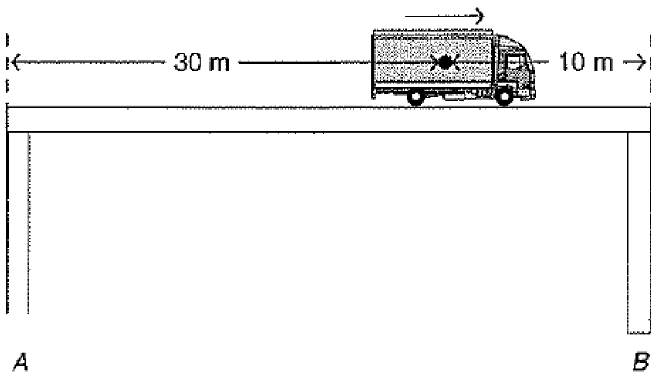


Figure 4

Question 21

Calculate the size of the force acting on the ground at point *A*.

kN

3 marks

Question 22

Calculate the size of the force acting on the ground at point *B*.

kN

3 marks

Question 23

Explain what happens to the size of the forces acting on the ground at points *A* and *B* as the truck continues to move across the bridge to the right from the spot shown in **Figure 4**.

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2 marks