TUTOR ZONE

# A Level Physics

## Mechanics

Duration: 1 hour and 15 minutes

Total Marks: 60

Information for Candidates:

- Use black or blue ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional paper is used, the question number(s) must be clearly shown
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

| *Do not write in this table* | |
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| Question | Mark |
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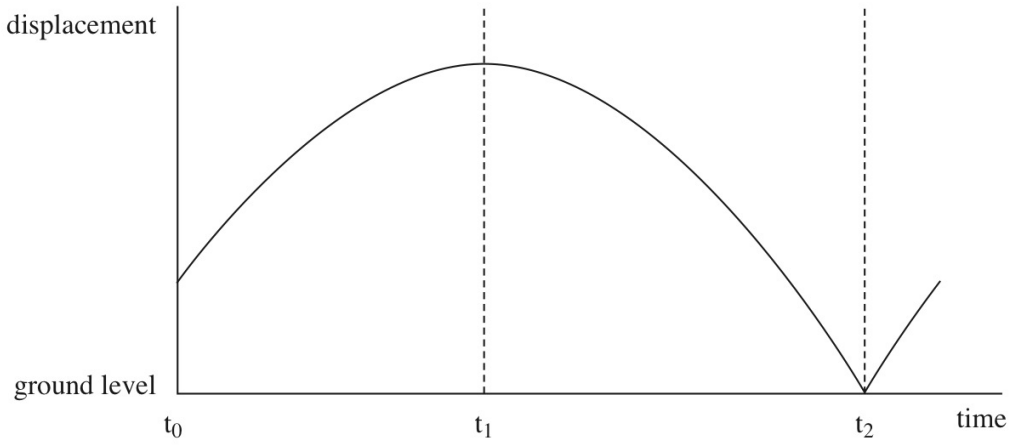
| TOTAL | |

Answer **all** questions in the spaces provided.

**1** A boy throws a ball vertically upwards and lets it fall to the ground. **Figure 1** shows how displacement relative to the ground varies with time for the ball.

**Figure 1**




**1 (a) (i)** State which feature of a displacement-time graph represents the velocity.

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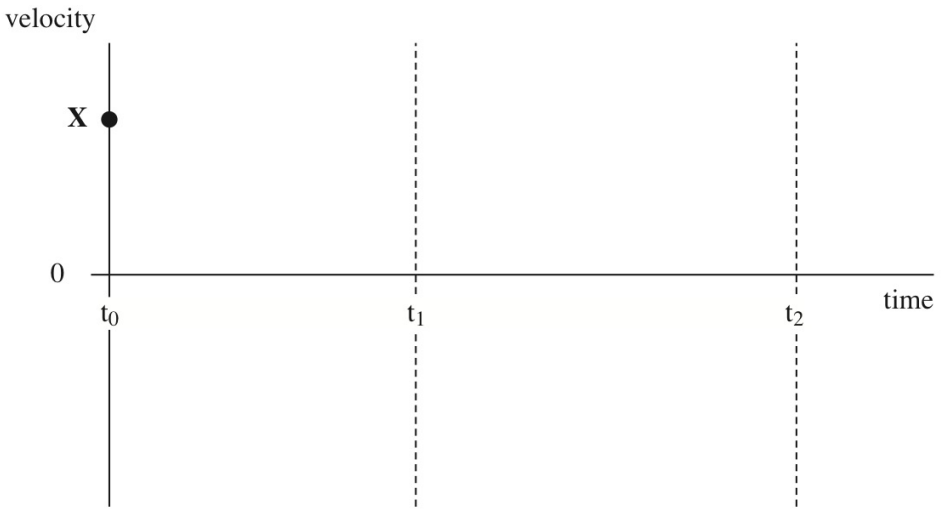
*(1 mark)*

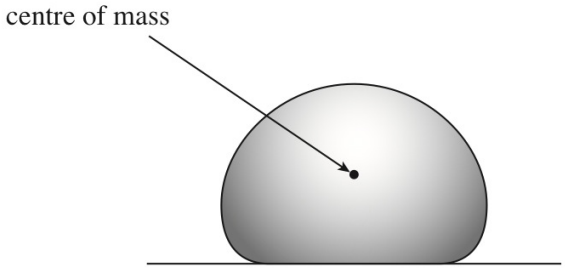
**1 (a) (ii)** On the axes below, draw the shape of the velocity-time graph for the ball between $t_0$ and $t_2$. The starting point is labelled **X**.

*(3 marks)*



**1 (b)** **Figure 2** shows the ball deforming as it contacts the ground, just at the point where it is stationary for an instant and has reached maximum deformation.

**Figure 2**




**1 (b) (i)** Explain how Newton's third law of motion applies to **Figure 2**.

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*(2 marks)*

**1 (b) (ii)** Explain why there is a resultant upward force on the ball in **Figure 2**.

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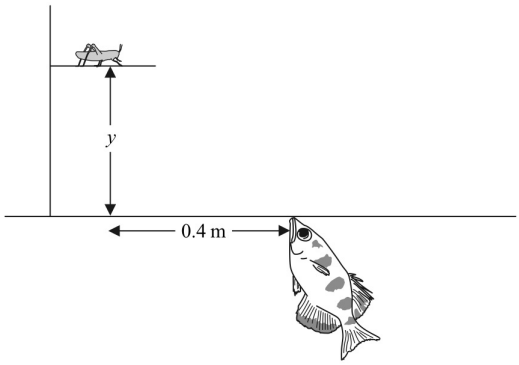
*(2 marks)*

8

**Turn over for the next question**

**13** Archer fish spit water droplets at insects from the surface of the water.

(a) The Archer fish spits a droplet of water with a velocity of 3.5 m $s^{-1}$ at an angle of 70° to the horizontal, aiming for an insect on a branch above the surface of the water. The horizontal distance to the insect is 0.4 m.




(i) Show that the initial horizontal component of velocity for the droplet is about 1 m $s^{-1}$.

**(2)**

(ii) Calculate the vertical distance, $y$, to the insect if the droplet hits the insect.

**(5)**

Distance = .....

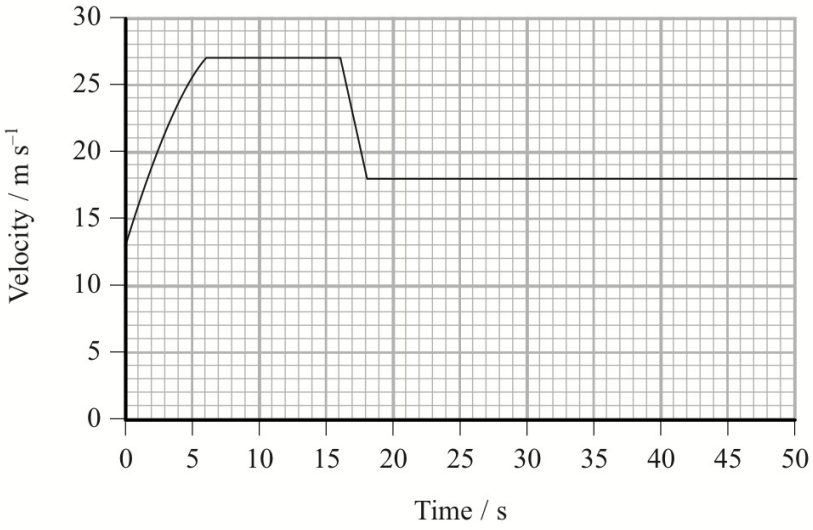
(b) Sketch the path of the water droplet on the diagram above.

**(1)**

**(Total for Question 13 = 8 marks)**

**17** The speeds of cars travelling through roadworks on major roads are often monitored by 'average speed check' cameras. This is done by timing a car between two cameras a large distance apart.


The graph shows how the velocity of a car varies with time as it passes between two average speed check cameras. The car passes the cameras at time $t = 0$ s and $t = 50$ s.



A constant driving force is applied to the car for the first 6 s. At time $t = 16$ s the driver realises the car is travelling too fast for the 22 m $s^{-1}$ speed limit (50 miles per hour) and applies the brakes until time $t = 18$ s.

(a) Calculate the acceleration at time $t = 3$ s.

**(3)**

Acceleration = .....

(b) Describe and explain the shape of the line in the first 6 s.

**(4)**

(c) Describe the resultant force on the car between times $t = 6$ s and $t = 16$ s.

**(1)**

(d) Show that the average speed of the car does not exceed the average speed limit of 22 m $s^{-1}$.

**(4)**

**(Total for Question 17 = 12 marks)**

**16** The photograph shows an arrangement used to launch a light, foam rocket at a school science competition.

The rocket is launched at the level of one end of a long table and lands at the other end at the same level. The students measure the horizontal distance travelled by the rocket and the time of flight.

(a) The rocket travels 1.88 m in a time of 0.88 s.

(i) Show that the horizontal component of the initial velocity of the rocket is about 2 m $s^{-1}$.

**(2)**

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(ii) Show that the vertical component of the initial velocity of the rocket is about 4 m $s^{-1}$.

**(2)**

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(iii) Calculate the initial velocity of the rocket.

**(4)**

Magnitude of initial velocity = .....

Angle to the horizontal of the initial velocity = .....

(b) The students obtained their data by filming the flight. When they checked the maximum height reached by the rocket they found it was less than the height predicted using this velocity.

(i) Suggest why the maximum height reached was less than predicted.

**(1)**

(ii) Give two advantages of filming the flight to obtain the data.

**(2)**

1 .....

2 .....

**(Total for Question 16 = 11 marks)**

**16** The photograph shows an athlete performing a long jump.

At take-off his horizontal speed is 8.0 m $s^{-1}$ and his vertical speed is 2.8 m $s^{-1}$.

(a) Show that the total time the athlete spends in the air is about 0.6 s.

Assume that his centre of gravity is at the same height at take-off and landing.

**(3)**

(b) Calculate the horizontal distance jumped by the athlete.

**(2)**

Horizontal distance = .....

(c) In reality, when the athlete lands his centre of gravity is 50 cm lower than its position at take-off.

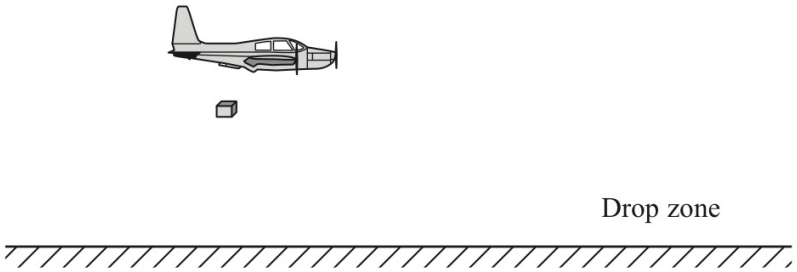
Calculate the extra horizontal distance this enables the athlete to jump.

**(4)**

Extra horizontal distance = .....

**(Total for Question 16 = 9 marks)**

**17** In areas of the world where a plane is unable to land, free fall airdrops can be used to deliver supplies.




A plane travelling at a speed of 75 m $s^{-1}$ and at a height of 63 m releases a package of supplies.

(a) (i) Draw the path of the falling package on the diagram above.

**(1)**

(ii) Show that the time taken for the supplies to reach the ground is about 4 s.

**(2)**

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(iii) Calculate the horizontal distance of the plane from the drop zone when releasing the package.

**(2)**

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Horizontal distance = .....

(b) (i) Show that the change in gravitational potential energy of the package during the fall is about 6 kJ.

mass of package = 10 kg

**(2)**

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(ii) Show that the kinetic energy of the package on release is about 28 kJ.

**(2)**

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(iii) Determine the kinetic energy of the package on impact.

**(1)**

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Kinetic energy = .....

(iv) State why in practice the actual value for the kinetic energy on impact with the ground is less than the value you calculated in part (b)(iii).

**(1)**

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(c) Most airdrops are not free fall and use parachutes.

State why using parachutes causes less damage to the package.

**(1)**

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**(Total for Question 17 = 12 marks)**