QQQ – Mechanics Year 1 – Chapter 8 – Introduction & Modelling (Version 1)

Total Marks: 23

(23 = Platinum, 21 = Gold, 18 = Silver, 16 = Bronze)

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1. A horizontal force of 30 N causes a crate to travel with an acceleration of 2 m s^{-2}, in a straight line, on a smooth horizontal surface.

Find the **weight** of the crate.

Circle your answer. **[1 mark]**

- 15 kg
- 15g N
- 15 N
- 15g kg

(Total 1 marks)

2. Jackie says:

"A person's weight on Earth is directly proportional to their mass."

Tom says:

"A person's weight on Earth is different to their weight on the moon."

Only one of the statements below is correct.

Identify the correct statement.

Tick (✓) **one** box. **[1 mark]**

- Jackie and Tom are both wrong.
- Jackie is right but Tom is wrong.
- Jackie is wrong but Tom is right.
- Jackie and Tom are both right.

(Total 1 marks)

3. One of the following is an expression for the distance between the points represented by position vectors $5\mathbf{i} - 3\mathbf{j}$ and $18\mathbf{i} + 7\mathbf{j}$

Identify the correct expression.

Tick (✓) **one** box. **[1 mark]**

- $\sqrt{13^2 + 4^2}$
- $\sqrt{13^2 + 10^2}$
- $\sqrt{23^2 + 4^2}$
- $\sqrt{23^2 + 10^2}$

(Total 1 marks)

4. A force $\mathbf{F}$ is $\begin{bmatrix} p \\ -0.5 \end{bmatrix}$ newtons, where p is a constant.

Given that the magnitude of $\mathbf{F}$ is 1.3 newtons, find the possible values of p **[3 marks]**

(Total 3 marks)

5. In this question the unit vectors $\mathbf{i}$ and $\mathbf{j}$ are directed east and north respectively.

A canal narrowboat of mass 9 tonnes is pulled by two ropes. The tensions in the ropes are $(450\mathbf{i} + 20\mathbf{j})$ N and $(420\mathbf{i} - 20\mathbf{j})$ N. The boat experiences a resistance to motion $\mathbf{R}$ of magnitude 300 N.

(a) Explain what it means to model the boat as a particle. **[1]**

The boat is travelling in a straight line due east.

(b) Find the equation of motion of the boat. **[2]**

(c) Find the acceleration of the boat giving your answer as a vector. **[1]**

(Total 4 marks)

6. An astronaut on the surface of the moon drops a ball from a point 2 m above the surface.

(a) Without any calculations, explain why a standard model using $g = 9.8 \text{ m s}^{-2}$ will not be appropriate to model the fall of the ball. **[1]**

The ball takes 1.6 s to hit the surface.

(b) Find the acceleration of the ball which best models its motion. Give your answer correct to 2 significant figures. **[2]**

(c) Use this value to predict the maximum height of the ball above the point of projection when thrown vertically upwards with an initial velocity of 15 m s^{-1}. **[2]**

(Total 5 marks)

7. A particle P is moving with constant velocity. The position vector of P at time t seconds $(t \geqslant 0)$ is $\mathbf{r}$ metres, relative to a fixed origin O, and is given by

$$\mathbf{r} = (2t - 3)\mathbf{i} + (4 - 5t)\mathbf{j}$$

(a) Find the initial position vector of P. **(1)**

The particle P passes through the point with position vector $(3.4\mathbf{i} - 12\mathbf{j})$ m at time T seconds.

(b) Find the value of T. **(3)**

(c) Find the speed of P. **(4)**

(Total 8 marks)