MEGA LECTURE

AQA, Edexcel, OCR

A Level

A Level Physics

MECHANICS: Newton's Laws

Name:

M M E

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Total Marks: /30

1. Newton's Laws.

Total for Question 1: 7

(a) State Newton's first law. [1]

(b) State Newton's second law, both in words and mathematically. [2]

(c) State Newton's third law. [1]

(d) Newton's second law is often written as $F = ma$. In what circumstances is this special case valid? Show how it can be obtained from your answer to Part b. [3]

2. Peter, a 65 kg swimmer, is practising his tumble-turns. Upon completion of the turn, he pushes against the wall with his legs and is set in motion for the next length. For this question, ignore the effects of water resistance.

Total for Question 2: 7

(a) Identify a 'third law pair' in this scenario (that is, a pair of forces of equal magnitude but opposing direction acting between two bodies). [1]

(b) The motion of the wall is imperceptible. Explain, in the context of Newton's second law, why this is so. [2]

(c) To accelerate at 5 ms^{-2}, with what force must Peter push off the wall? [1]

(d) Peter's speed increases throughout the entirety of his 5 m underwater glide, during which he makes no further efforts. Given the acceleration above, if the glide takes 1 s, at what speed does Peter emerge at the surface? [2]

(e) The mass of Earth is approximately 5.97×10^{24} kg. What acceleration is induced by Peter's turn? [1]

3. Qamar is stood still on a set of weighing scales. They read 490 N.

Total for Question 3: 4

(a) She is handed a ball with a mass of 2 kg. What do the scales now read? [1]

(b) Draw a schematic graph of how the scales' reading changes with time when Qamar forcefully throws the ball downwards and explain using Newton's laws why the changes occur. [3]

4. A canon is fired vertically upwards. At its highest point of 150 m, the 3 kg canon-ball explodes into six pieces of equal mass. These are ejected along three orthogonal axes, one of which is oriented vertically. Along each axis two pieces travel in opposite directions. All fragments initially have a speed of 20 ms^{-1}. Ignore the effects of air resistance.

Total for Question 4: 12

(a) The symmetry of this explosion is not mere coincidence. Explain, using your knowledge of Newton's laws, why it is necessarily symmetric. [3]

(b) Calculate both the vertical component of the velocity and the speed of each piece as it makes landfall. For this you will need to use a SUVAT equation. [4]

(c) With what kinetic energy was the canon-ball fired? [2]

(d) The canon weighs 981 N. When it fires, will it recoil with a smaller or larger acceleration than that of the canon-ball? By what factor will it be different? Make clear any applications of Newton's laws in this calculation. [3]