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Support Pack | Grade 12

CAPS

Physical Sciences

Mechanics

This support pack for the **Mechanics** module in the **Physical Sciences Grade 12 CAPS curriculum** provides valuable practice exercises. All questions have the answers provided. Learners can work through these individually at home or these could form the basis of a catch-up class or online lesson. You have permission to print or photocopy this document or distribute it electronically via email or WhatsApp.

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Revision exercises for Mechanics

Question 1

When is a body in free fall?

Question 2

What force is responsible for projectile motion?

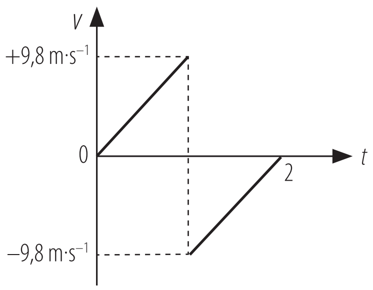
Question 3

The gravitational acceleration on Mars is 3,71 $m \cdot s^{-2}$ and on Jupiter it is 24,79 $m \cdot s^{-2}$.

a) Give the symbol, magnitude and direction of the gravitational acceleration on Earth.
b) If a ball is thrown upwards with the same initial velocity on all three planets, on which planet will it reach the greatest maximum height? Explain your answer by referring to a physics equation.

Question 4

A ball is dropped to the ground and it bounces back. The velocity-time graph for the motion is given below.



a) What is the acceleration of the ball?
b) Use the velocity-time graph to calculate how high the ball was from the ground when it was dropped.
c) Draw a position-time and acceleration-time graph for the motion of the ball.

Question 5

A boy fires a pellet gun into the air. The bullet leaves the barrel of the gun at a speed of 220 $m \cdot s^{-1}$.

a) Calculate the maximum height that the bullet reaches.
b) Calculate how long the bullet takes to:
   i) reach the maximum height
   ii) land on the ground.

Question 6

A crane is hoisting a container of bricks to the top of a construction site at a constant speed. When the container is 20 m above the ground, one brick dislodges and falls to the ground below. The brick strikes the ground 2,5 s later.

a) Calculate the constant speed of the container.
b) How long after the brick dislodges and starts to fall will it be 25 m from the brick container?

Question 7

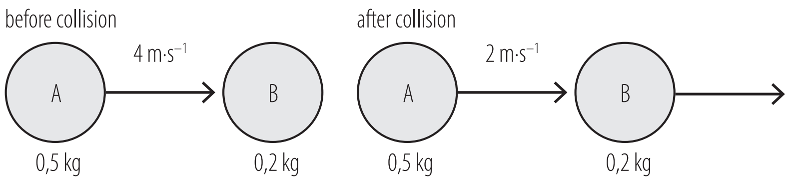
State the principle of conservation of momentum.

Question 8

Distinguish between elastic and inelastic collisions.

Question 9

Two balls collide. Ball A has a mass of 0,5 kg and an initial velocity of 4 $m \cdot s^{-1}$. Ball B has a mass of 0,2 kg and is stationary. After the collision, the balls move off in the same direction as Ball A moved before the collision, with Ball A at a velocity of 2 $m \cdot s^{-1}$.



a) Calculate the velocity of Ball B after the collision.
b) Is this an elastic or inelastic collision? Show your workings.

Question 10

Define the work done on an object by a force.

Question 11

Classify the following examples as work done on the object by the applied force, or work not done on the object by the applied force.

a) A spacecraft travelling around Earth in a circular orbit
b) A light bulb falling to the floor
c) Lifting a heavy weight above your head
d) Holding a heavy weight above your head
e) Pushing a crate up a slope
f) Carrying a bag of groceries

Question 12

A man is mowing the lawn and he pushes the lawnmower with a force of 80 N at an angle of 70° to the horizontal. The total length that he must walk to cover the whole lawn is 100 m. Calculate the work done by the man.

Question 13

In order to break a large rock, a 100 kg iron ball is dropped on the rock from a distance above it. Explain why more work can be done by the iron ball if it is lifted to a greater height.

Question 14

A helicopter hovering 100 m above sea level drops a 2 kg lifebuoy to a man at sea during a rescue operation.

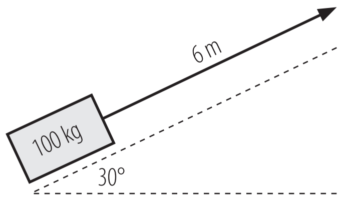
a) Use energy conversions to calculate the velocity of the lifebuoy when it hits the water. Ignore the effect of air resistance.

After hitting the water, the buoy sinks to a depth of 10 cm.

b) What is the work done by the water to stop the buoy?
c) Calculate the upward force of the water on the buoy.

Question 15

A force of 600 N is applied to a 100 kg crate to pull it up a 30° slope over a distance of 6 m.



a) Calculate the potential energy gain when the crate reaches the top of the slope.
b) Calculate the amount of work done to pull the crate up the slope.
c) If the crate has a speed of 2 m·s^{-1} when it reaches the top of the slope, calculate the energy used to overcome the friction between the crate and the slope surface.

Question 16

A 5 000 kg truck is travelling down a hill when its brakes fail. At the bottom of the hill the driver steers the truck, now travelling at 30 m·s^{-1}, into a sand trap on the side of the road, which causes the truck to slow down with constant acceleration.

a) Calculate the kinetic energy of the truck when it enters the sand trap.
b) Calculate the force exerted by the sand on the truck if it comes to a halt in 30 m.

Question 17

A truck's engine provides a motive force of 1 200 N when the truck is travelling at a constant speed of 30 m·s^{-1}. What is the truck's power output?

Memorandum for revision exercises

1 A free-falling body is one which is moving such that the only force acting on it is the gravitational force of the Earth.

2 gravitational force

3 a) $g = 9{,}8\ \text{m·s}^{-2}$, towards the centre of the Earth (or downwards)

b) From $v_f^2 = v_i^2 - 2g\Delta y$, we have: $v_i^2 = 2g\Delta y$

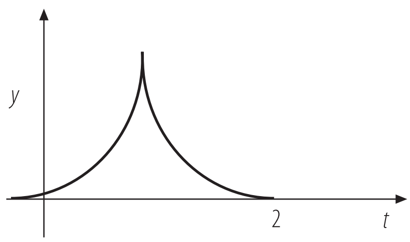
($v_f = 0$ at maximum height) and $\Delta y = \dfrac{v_i^2}{2g}$

Thus Δy is inversely proportional to g, since v_i is the same on all the planets. The ball will reach the maximum height on the planet with the smallest g, i.e. on Mars.

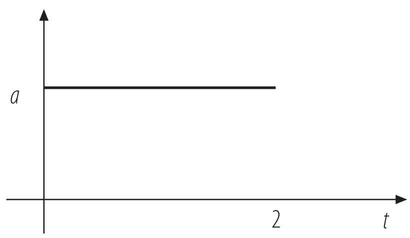
4 a) $9{,}8\ \text{m·s}^{-1}$

b) 4,9 m

c) If we take the point at which the ball was dropped as our origin, and the downwards direction as positive, then the position-time graph will be as follows:



If we take the point at which the ball was dropped as our origin, and the downwards direction as positive, then the acceleration-time graph will be as follows:



5 a) 2 469,39 m

b) i) 22,45 s

ii) 44,90 s

6 a) $4{,}25\ \text{m·s}^{-1}$

b) 2,26 s

7 In an isolated system, the total linear momentum is constant in both magnitude and direction.

8 In an elastic collision, both the momentum and kinetic energy are conserved, while in an inelastic collision only the momentum is conserved, but not the kinetic energy.

9 a) $5\ \text{m·s}^{-1}$

b) Total kinetic energy of the balls before collision is:

$$KE_{A_i} + KE_{B_i} = \frac{1}{2}mv_{A_i}^{\ 2} + \frac{1}{2}mv_{B_i}^{\ 2} = \frac{1}{2}(0{,}5\ \text{kg}) \times (4\ \text{m·s}^{-1})^2 + 0 = 4\ \text{J}$$

Total kinetic energy of the balls after collision is:

$$KE_{A_f} + KE_{B_f} = \frac{1}{2}mv_{A_f}^{\ 2} + \frac{1}{2}mv_{B_f}^{\ 2} = \frac{1}{2}(0{,}5\ \text{kg}) \times (2\ \text{m·s}^{-1})^2 + \frac{1}{2}(0{,}2\ \text{kg}) \times (5\ \text{m·s}^{-1})^2 = 3{,}5\ \text{J}$$

Since the total kinetic energy of the balls after the collision is less than the total kinetic energy of the balls before the collision, the collision is inelastic.

10 The work done on an object is the product of the force applied on the object and the displacement produced in the direction of the force.

11 a) Zero work is done, since the applied force is perpendicular to the displacement.
b) Work is done by the gravitational force.
c) Work is done by you.
d) Zero work is done since there is no displacement.
e) Work is done by the pushing force.
f) Zero work is done since the carrying force is perpendicular to the displacement of the groceries.

12 2 736,16 J

13 Work is done by the gravitational force on the iron ball to bring it to the ground, and this work is given by: $W_{grav} = F_{grav} \times \Delta y = mg\Delta y$
Since m and g are constant, $W_{grav} \propto \Delta y$. This work done by gravity is converted into the kinetic energy of the ball. Therefore, the ball will land with a larger kinetic energy if it is lifted to a greater height. The larger the kinetic energy of the ball, the more work can be done by the ball.

14 a) 44,27 $m \cdot s^{-1}$
b) 1 957,87 J
c) 1 957,72 N

15 a) 2 940 J
b) 3 600 J
c) 460 J

16 a) $2,25 \times 10^{6}$ J
b) $7,5 \times 10^{4}$ N

17 $3,6 \times 10^{4}$ W