Pearson Edexcel

Additional Assessment Materials
Summer 2021

Pearson Edexcel GCSE in Physics (1PH0)
Higher

Resource Set Topic A: Motion and Forces

Questions

(Public release version)

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

6 (a) The symbol '*g*' can be used to refer to the acceleration due to gravity.

The acceleration due to gravity '*g*' has the unit of m/s^2.

'*g*' can also have another unit.

Which of these is also a unit for *g*?

(1)

- ☐ **A** J/kg
- ☐ **B** J/kg^2
- ☒ **C** N/kg
- ☐ **D** N/kg^2

(b) Two students try to determine a value for *g*, the acceleration due to gravity.

(i) They measure the time, *t*, for a small steel ball to fall through a height, *h*, from rest.

They measure *t* to be 0.74 s, using a stopwatch.

They measure *h* to be 2.50 m, using a metre rule.

Calculate a value for *g* from the students' measurements.

Use the equation

$$g = \frac{2h}{t^2}$$

(2)

$$= \frac{2 \times 2.5}{(0.74)^2} \approx 9.13$$

$g =$ 9.13 m/s^2

(ii) They record the time t for two more drops from the same height.

The three values for time t are

0.74 s, 0.69 s, 0.81 s.

Calculate the average value of time t to an appropriate number of significant figures.

(2)

$$\frac{0.74+0.69+0.81}{3} = \frac{2.24}{3} \approx 0.75$$

average value of time t = 0.75 s

(c) Explain **one** way the students could improve their procedure to obtain a more accurate value for g.

(2)

Use a light gate to electronically time the measurement in-order to eliminate the reaction time.

(d) A car travelling at 15 m/s comes to rest in a distance of 14 m when the brakes are applied.

Calculate the deceleration of the car.
Use an equation selected from the list of equations at the end of this paper.

(3)

$$v^2 = u^2 + 2as$$

$$a = \frac{v^2 - u^2}{2s}$$

$$= \frac{0 - 15^2}{2(14)}$$

$$= \frac{-225}{28} = {}^{-}8.0357 \approx {}^{-}8.04$$

deceleration = 8.04 m/s²

9 (a) A student investigates the relationship between force and acceleration for a trolley on a runway.

Figure 12 shows some of the apparatus the student uses.

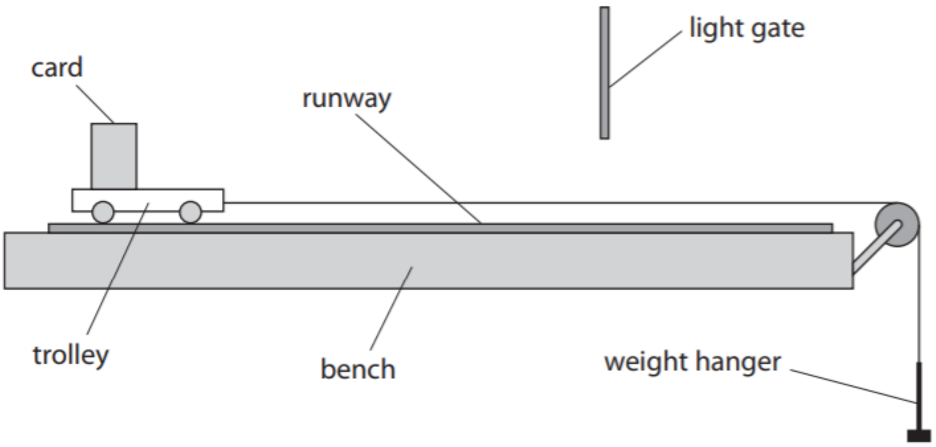


Figure 12

(i) Describe how the student could increase the accelerating force applied to the trolley.

(2)

Add masses to the weight hanger.

(ii) Describe how the mass of the moving system can be kept constant.

(2)

Keep all the masses needed for the experiment in the trolley and transfer to the hanger when required.

*(b) Figure 13 shows two objects, Q and R, before and after they collide.

Figure 13

The arrows show the direction of movement of the objects.
The arrows are not to scale.

Explain how momentum is conserved in the collision.

Use Newton's third law and Newton's second law in your answer.

Newton's second law can be written as

$$\text{force} = \frac{\text{change in momentum}}{\text{time}}$$

(6)

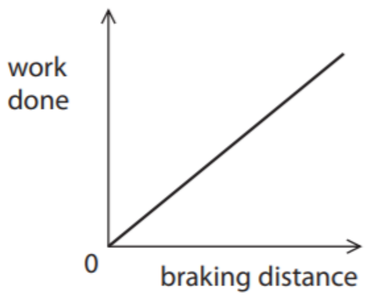
When the balls collide, Q exerts a force on R and R exerts a force of the same magnitude but opposite direction on Q. Hence, the rate of change in momentum of both balls are equal in magnitude. Since the time taken for the collision is the same for both balls, the change in momentum of both balls are equal in magnitude. This explains that there is a transfer of momentum between Q and R Furthermore, since the force exerted by R is opposite in direction (negative in analysis), the rate of change of momentum is negative and hence the momentum of Q= - momentum of R Since the directions of the momentum are different, there is no overall change in momentum.

1 (a) The work done to bring a car to rest is given by the equation

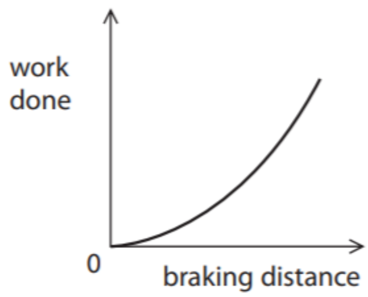
work done = braking force × braking distance

Which of these graphs is correct for the car if a constant braking force is applied?

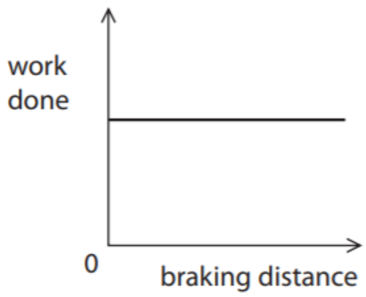
(1)



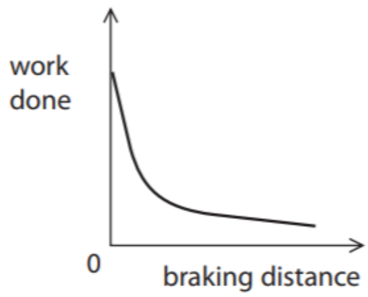
☒ **A**



☐ **B**



☐ **C**



☐ **D**

(b) Before the car brakes it has kinetic energy.
The kinetic energy decreases as it brakes.

State what happens to the kinetic energy during braking.

(1)

The kinetic energy converts to thermal energy.

(c) The graph in Figure 1 shows how the braking distance, d, of a car depends on the velocity, v, of the car when the brakes are first applied.

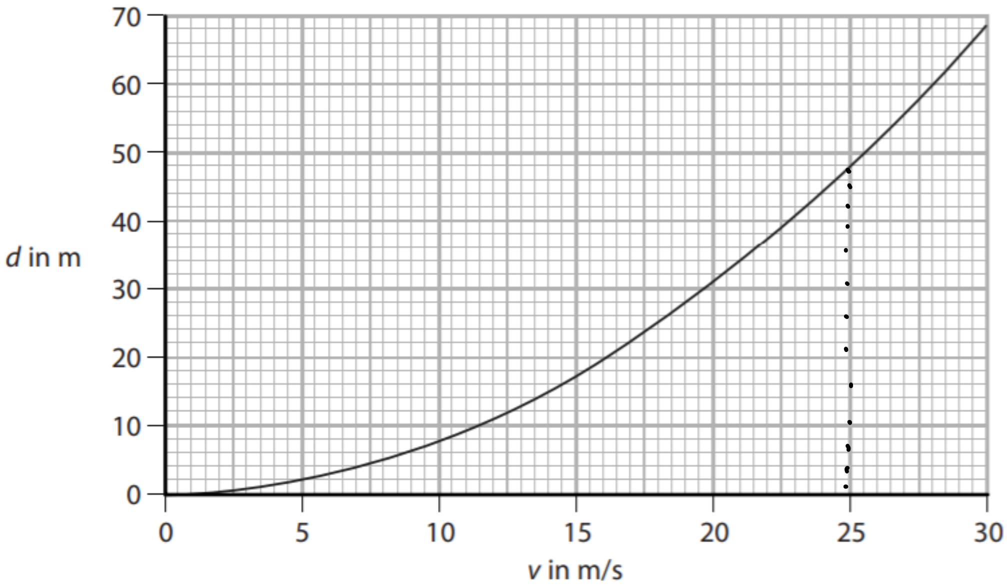


Figure 1

An equation relating braking distance, d, to velocity, v, is

$$d = \frac{v^2}{C}$$

where C is a constant.

Use the equation and data from the graph in Figure 1 to calculate a value for C.

Give a unit for C.

(4)

$$48 = \frac{25^2}{C}$$

$$C = \frac{25^2}{48} = \frac{625}{48} = 13.02 \approx 13.0$$

$$m = \frac{(m/s)^2}{C}$$

$$C = \frac{m^2}{s^2} \times \frac{1}{m}$$

$C =$ 13 unit m/s^2

7 (a) The force that keeps an object moving in a circular path is known as the

(1)

- ☐ **A** balancing force
- ☒ **B** centripetal force
- ☐ **C** reaction force
- ☐ **D** resistance force

(b) Figure 11 shows an object moving in a circular path.

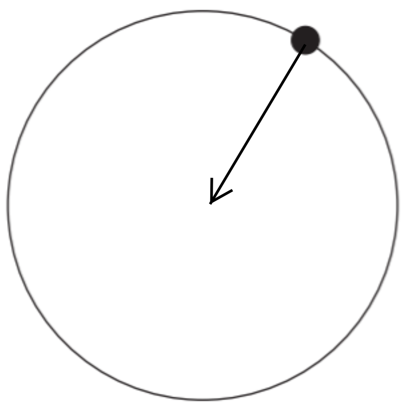


Figure 11

(i) Draw an arrow on Figure 11 to show the direction of the force that keeps the object moving in a circular path.

(1)

(ii) The object in Figure 11 is moving at constant speed.

Explain why it is not moving with constant velocity.

(2)

Velocity is a vector and it has both a magnitude and a direction. During the objects motion, the direction constantly changes and hence the velocity changes.

(c) Figure 12 shows a skier on a slope.

The skier travels down the slope with a constant acceleration.

The speed of the skier is measured at points P and Q.

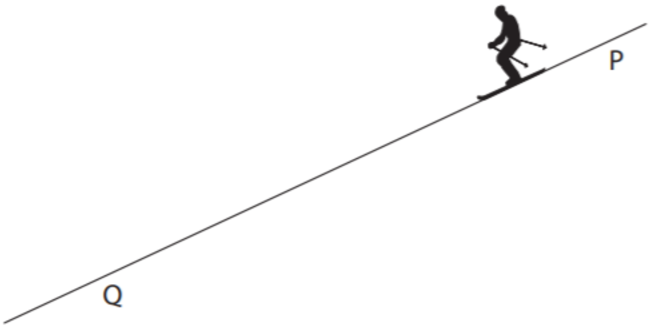


Figure 12

The table in Figure 13 gives some data about the skier making one downhill run.

acceleration	3.0 m/s²
speed at P	7.6 m/s
speed at Q	24 m/s

Figure 13

(i) Calculate the distance from P to Q.

Use an equation selected from the list of equations at the end of this paper.

(3)

$v^2 = u^2 + 2as$

$24^2 = (7.6)^2 + 2(3)(s)$

$s = \dfrac{24^2 - (7.6)^2}{6}$

$= 86.37 \approx 86$

distance from P to Q = 86 m

(ii) Calculate the time taken for the skier to travel from P to Q.

(3)

$V = u + at$

$24 = 7.6 + 3t$

$\frac{24 - 7.6}{3} = t = 5.4\dot{6} \approx 5.5$

time from P to Q = 5.5 s

3 (a) Which of these is a vector?

(1)

☐ **A** energy

☒ **B** force

☐ **C** mass

☐ **D** work

(b) (i) State the equation that relates acceleration to change in velocity and time taken.

(1)

$a = \frac{\Delta v}{t}$ / $a = \frac{v - u}{t}$

(ii) A van accelerates from a velocity of 2 m / s to a velocity of 20 m / s in 12 s.

Calculate the acceleration of the van.

(2)

$= \frac{v-u}{t}$

$= \frac{20-2}{12}$

$= \frac{18}{12} = 1.5$

acceleration = 1.5 m / s²

(c) Figure 3 is a velocity / time graph for 15 s of a cyclist's journey.

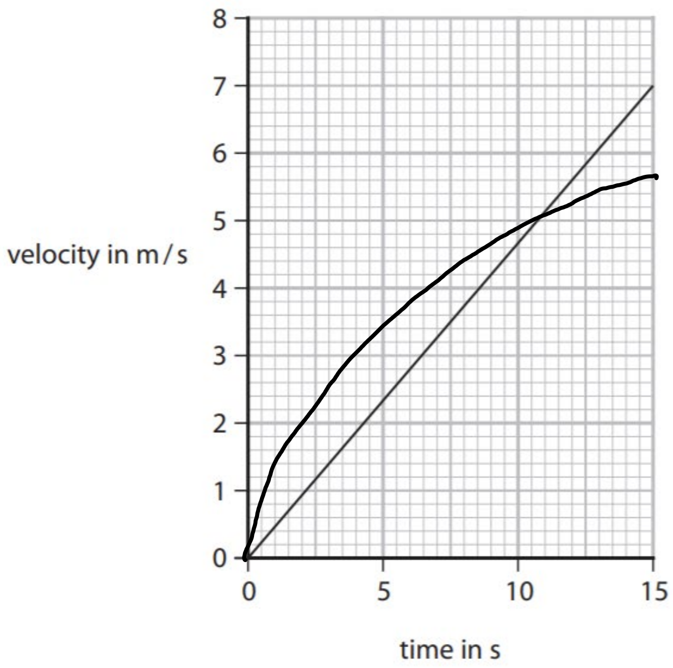


Figure 3

(i) Calculate the distance the cyclist travels in the 15 s.

(3)

distance travelled = Area under the graph

$= \frac{1}{2} \times 15 \times 7$

$= 52.5 \approx 53$

distance = 53 m

(ii) Another cyclist starts from rest, but his acceleration decreases as time increases.

Sketch the velocity / time graph for this cyclist on Figure 3.

(2)

9 (a) Figure 12 is a diagram showing a rocket that is sent into space to try and change the path of a small asteroid.

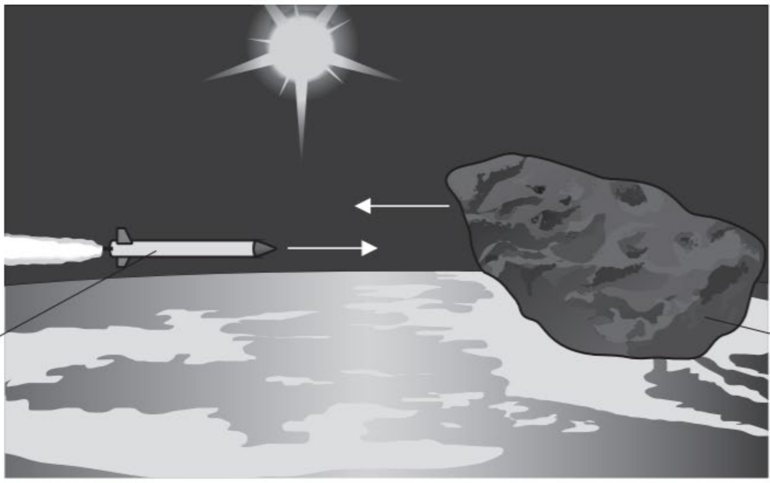


Figure 12

(i) The rocket has a mass of 5.5×10^5 kg and is travelling to the right at 14 km/s.

Which of these is a correct calculation of the momentum of the rocket in kg m/s?

Use the equation

$$p = m \times v$$

(1)

☐ **A** 7.7×10^3 kg m/s

☐ **B** 7.7×10^6 kg m/s

☒ **C** 7.7×10^9 kg m/s

☐ **D** 7.7×10^{12} kg m/s

(ii) The asteroid has a momentum of 7.5×10^{10} kg m/s and a mass of 8.0×10^6 kg.

Calculate the speed of the asteroid.

(2)

$P = m \times v$

$7.5 \times 10^{10} = 8 \times 10^6 \times v$

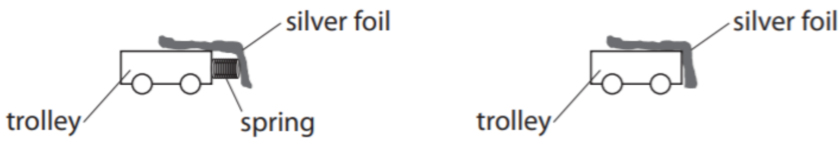
$v = \frac{7.5 \times 10^{10}}{8 \times 10^6}$

$= 9375$

speed of the asteroid = 9375 m/s

*(b) A student investigates the effect of a crumple zone on the force exerted during a collision.

The student has one trolley with a spring at the front and another trolley without a spring.



The student uses the arrangement in Figure 13.

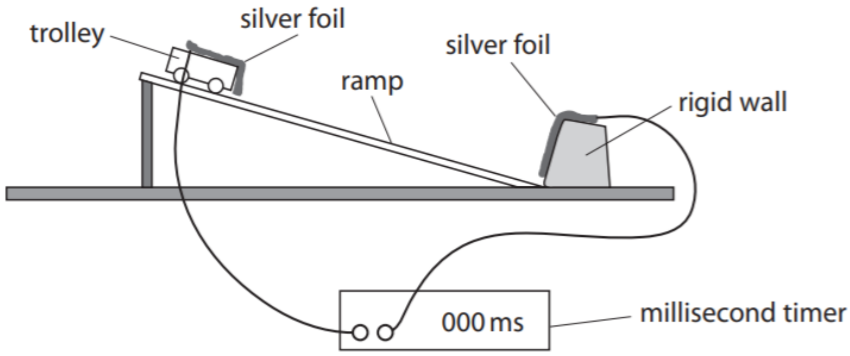


Figure 13

After a trolley is released, it accelerates down a slope and bounces off a rigid wall.

The speed of a trolley can be measured just before a collision with the wall and just after a collision with the wall.

The silver foils are connected to a millisecond timer.

The silver foils make contact with each other during the collision, so the time they are in contact can be read from the millisecond timer.

Explain how the student could investigate the effect of a crumple zone on the average force exerted during the collision.

Your explanation should include:

- how to determine the force (you may wish to refer to an equation from the list of equations at the end of this paper)
- how the effect of crumple zones may be shown in the investigation
- precautions that may be necessary to achieve accurate results.

(6)

Measure the mass of the trolley without the spring (M). Calculate the speed of the trolley by placing a light gate near the end of the ramp, a known distance (d) from each other; measuring time taken to pass through the gates (t) and using the equation speed = d/t. Release the trolley from a known point in the ramp and measure the speed of the trolley before impact (V1) and after the rebound (v2). Repeat the motion of the trolley from the same position in the ramp multiple times and get and get a mean value for V1 and V2. Calculate the change in momentum (ΔM) of the trolley by M x(V2-V1) and obtain the absolute value. Force can be calculated by the equation F = ΔM/t. Repeat the above experiment using the trolley with the spring and calculate the force of the impact (F2). If the force is smaller, the system is safer.

(c) Newton's third law, when applied to the collision of the rocket and the asteroid as shown in Figure 12, can be stated as follows:

The force exerted by the rocket on the asteroid is equal and opposite to the force exerted by the asteroid on the rocket.

Explain how this statement links to the conservation of momentum in the collision.

(4)

From the equation force= $\frac{\text{Change in momentum}}{\text{time}}$, the rate of change in momentum of both the rocket (R) and the asteroid (A) are related by $\frac{\text{Change in momentum of R}}{\text{time}} = -\frac{\text{Change in momentum of A}}{\text{time}}$. Since the time taken for the collision is the same for both objects, the change in momentum of both objects are equal in magnitude. This explains that there is a transfer of momentum between R and A. Furthermore, since the rate of change of momentum in A is negative, the momentum of R= - momentum of A. Since the directions of the momentum are different, there is no overall change in momentum.

TOTAL FOR PAPER IS 58 MARKS