Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE AS Physics

Topic 2: Mechanics

Test1

(Public release version)

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

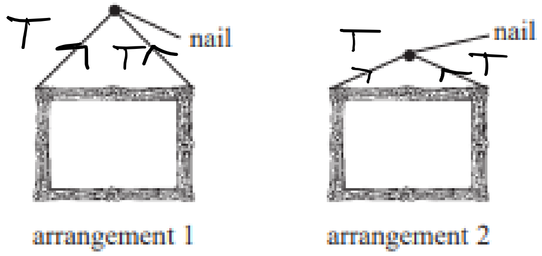
- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate’s grade.
- 2021 Additional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- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.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

1

10 A thin wire of negligible mass is used to hang a picture on a wall. The wire is hung over a nail and can be attached to the picture using arrangement 1 or arrangement 2, as shown.



(a) Deduce which wire arrangement should be used to keep the tension in the wire as small as possible.

(4)

Resolving vertically: $2T\cos\theta = mg$

so $T\cos\theta = \frac{mg}{2}$ so $T = \frac{mg}{2\cos\theta}$.

In arrangement 1, θ is smaller so

$\cos\theta$ is bigger and as $T = \frac{mg}{2\cos\theta}$, Tension is

smaller in arrangement 1.

(b) It was observed that if the wire was not hung with its midpoint over the nail, as in Diagram 1, the picture moved and then remained in the position shown in Diagram 2.

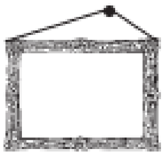


Diagram 1

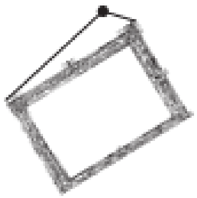


Diagram 2

Use the idea of moments to explain why.

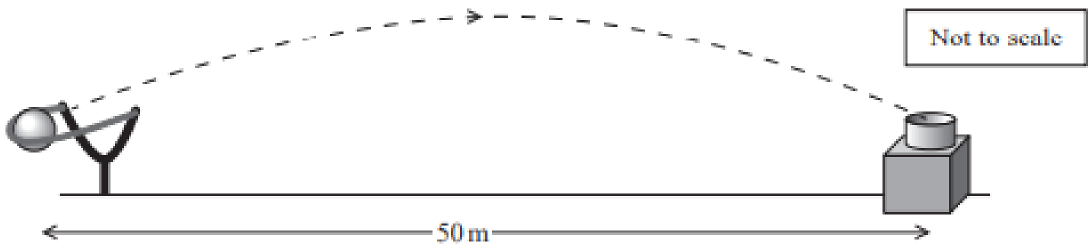
(3)

The centre of mass is not directly below the pivot so there is a resultant anticlockwise moment and the picture moves until centre of mass is directly below the pivot.

(Total for Question 10 = 7 marks)

11 A fairground game requires the player to catapult a ball towards a target to score points.

The ball is required to reach a target a horizontal distance of 50 m away, at the same vertical height, as shown.



(a) The time taken for the ball to reach the target is 2.0 s.

Calculate the angle to the horizontal at which the ball is launched.

(4)

$u_h = \frac{50}{2} = 25 m/s$

$s_y = u_v t + \frac{1}{2} a t^2$ so $0 = 2u_v - 4.9(2^2)$

so $u_v = \frac{19.6}{2} = 9.8 m/s$.

$\tan\theta = \frac{u_v}{u_H} = \frac{9.8}{25} \Rightarrow \theta = 21.4°$

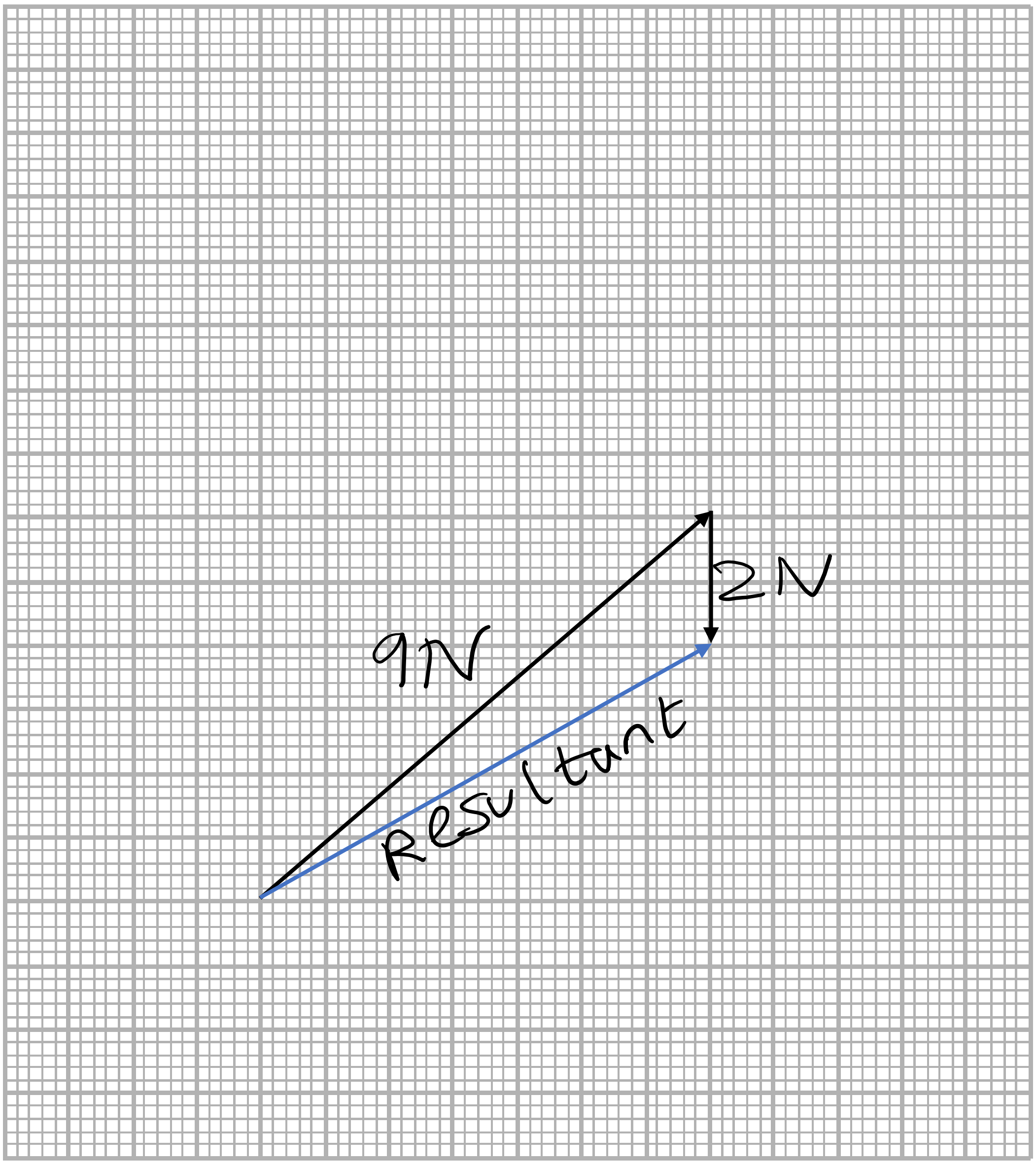
Angle to the horizontal = 21.4°

(b) During another launch, the catapult exerts a force on the ball of 9.0 N at 40° to the horizontal at the time of release.

Draw a labelled vector diagram to determine the resultant force acting on the ball at the time of release.

(4)

weight of ball = 2.0 N



Magnitude of resultant force = 7.8N

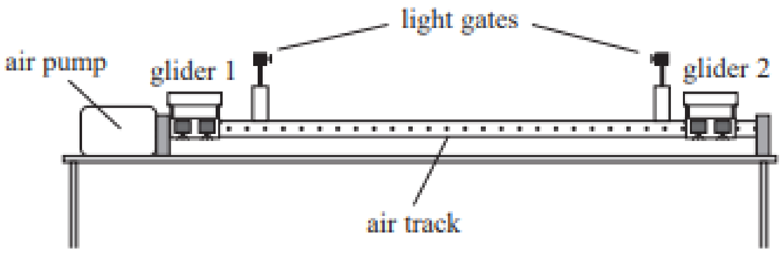
Angle of resultant force to the horizontal = 29°

(Total for Question 11 = 8 marks)

3

12 A teacher uses a linear air track to provide a frictionless surface for two gliders, each of mass m. She uses this, with a pair of light gates connected to a computer, to investigate a collision between the gliders.

The gliders are each given a small push and travel towards the centre of the track. The gliders collide and move off together.



(a) The computer displays the velocity of the gliders as they pass through the light gates.

Calculate the velocity of the gliders after the collision, using the principle of conservation of linear momentum.

(3)

initial velocity of glider 1 = $0.30\,\mathrm{m\,s^{-1}}$ to the right

initial velocity of glider 2 = $0.70\,\mathrm{m\,s^{-1}}$ to the left

+ve →

$mu_1 + mv_2 = mv$ so $0.3m - 0.7m = 2mv$

so $2mv = -0.4m$ so $v = -0.2$ m/s

so velocity is 0.2 m/s to the left

Magnitude of velocity = 0.2

Direction of velocity = to the left

(b) The teacher asked a student to justify the change in velocity of glider 1 using Newton's laws of motion.

The student began his explanation with the statement:

"During the collision there is a force on glider 2"

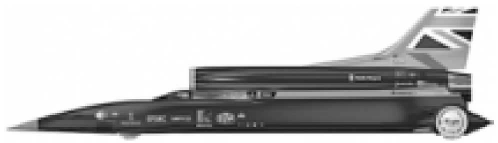
Complete the explanation to justify the change in velocity of glider 1, making reference to Newton's laws of motion where appropriate.

(4)

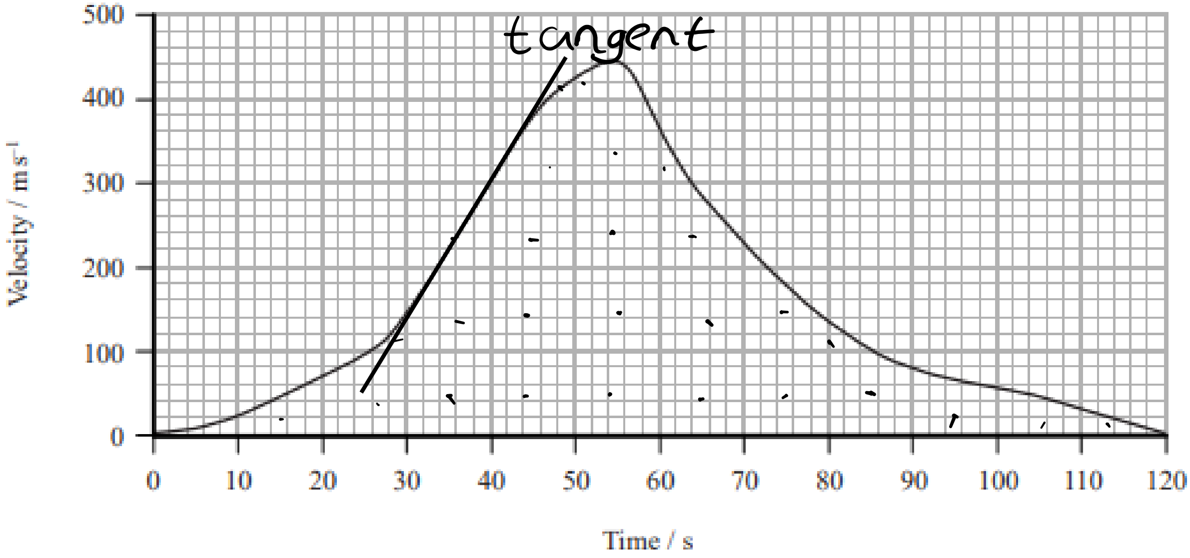
Glider 1 exerts a force on glider 2 and due to Newton's Third Law, Glider 2 exerts an equal and opposite force on glider 1. Thus, there is a resultant force on glider 1 and due to Newton's 1st law, Glider 1 accelerates leading to a change in velocity.

(Total for Question 12 = 7 marks)

14 The world land speed record of 341 m s^{-1} was set in October 1997. In an attempt to break this record, a new supersonic car has been developed called the Bloodhound.



The developers of the Bloodhound have used computer modelling to produce a velocity-time graph for the predicted motion of the car, on a straight track, during the record attempt.



(a) A track of length 23 km is available for the record attempt.

Determine whether this track is long enough.

(3)

Area under curve = 10 full squares + 18 half squares
= 19 full squares = 19 × 1000
= 19000 m.
19000 < 23000 so length is long enough.

(b) The car has two different engines: a jet engine providing a thrust of 89 kN and a rocket engine providing a thrust of 120 kN.

(i) The jet engine runs throughout the car's acceleration stage. The rocket engine runs for only part of that stage.

State the time at which the rocket engine is started during the car's predicted motion.

(1)

26 seconds

(ii) Use the graph to determine the maximum positive acceleration of the car.

(2)

acceleration = gradient of tangent

$= \frac{400-200}{46-34} = \frac{200}{12} = 16.7 m/s^2$ (3sf)

Maximum positive acceleration of the car = 16.7

(iii) Calculate a value for the frictional force acting on the car when the positive acceleration is a maximum.

(3)

mass of car including fuel at this time = 7790 kg

$F_{res} = ma = 7790 \times 16.7 = 130,000$ N (3sf)

$130,000 = (89+120) \times 10^3 -$ Friction

so Friction = 209000 − 130000

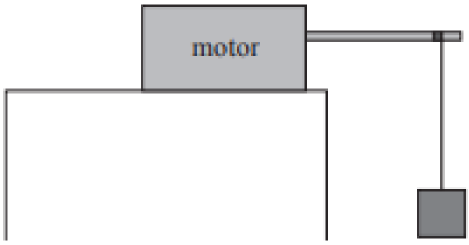
= 79000 N

Frictional force during maximum positive acceleration = 79000 N

5

9 A motor lifts a block of mass 0.050kg at a constant velocity of 0.40 m s^{-1}.

The current in the motor is 85mA and the potential difference across it is 3.0V.



Calculate the efficiency of the motor.

(3)

$P = IV = (85 \times 10^{-3}) \times 3 = 0.255 W$

$E = Pt$. Assume $t = 1$ so $P = mg\Delta h$.

$P = 0.05 \times 9.81 \times 0.4 = 0.1962 W$

$\text{Efficiency} = \frac{0.1962}{0.255} \times 100 = 77\%$

Efficiency of the motor = 77%

(Total for Question 9 = 3 marks)

11 A motorist received a speeding penalty notice, from the police, for a short journey along 120 m of road.

(a) The car's specification states that the minimum time for the car to accelerate from 0 to 60 miles per hour is 9.5 seconds.

Show that the maximum value for the average acceleration of the car over 9.5 s is about 3 m s^{-2}.

1 mile = 1600 m

(2)

$60\text{mph} = \frac{60 \times 1600}{3600} = 26.7\text{ms}^{-1}$

$a = \frac{v-u}{t} = \frac{26.7}{9.5} = 2.8\text{m/s}^2$

(b) The police recorded a maximum speed for the car of 20 m s^{-1}.

The motorist knows that the speed at the start and at the end of the 120 m journey was zero.

Assume that the car had:

- constant positive acceleration, equal to the value in part (a), for the first 60 m of the journey
- constant negative acceleration of the same magnitude for the final 60 m of the journey.

Determine whether the motorist should challenge the penalty notice.

(3)

$v^2 = u^2 + 2as = 0 + 2(2.8)(60)$
$= 336$ so $v = 18\text{m/s}$

The maximum speed with manufacturers acceleration is 18 m/s which is less than the 20 m/s recorded by the police so motorist should challenge the notice.

(c) Explain why the assumptions about the acceleration in (b) may **not** be correct in practice.
(2)

As air resistance increases with speed so acceleration decreases at higher speeds. The car could brake with greater negative acceleration than the positive acceleration

(Total for Question 11 = 7 marks)

TOTAL FOR PAPER IS 41 MARKS