Energy Stores and Changes

Questions

Name: _____

Class: _____

Date: _____

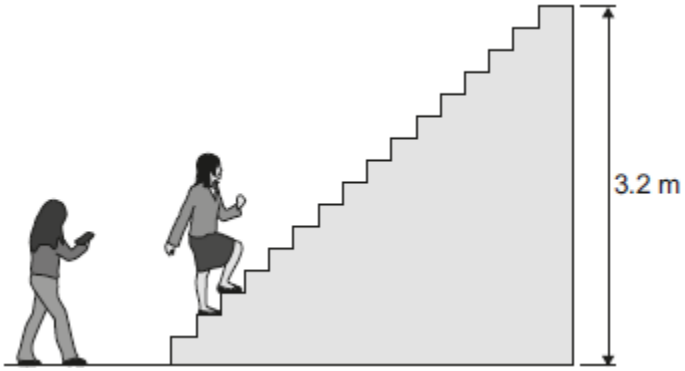
Time: **76 minutes**

Marks: **75 marks**

Comments:

1 A student did an experiment to calculate her power.
The diagram below shows how she obtained the measurements needed.

The student first weighed herself and then ran up a flight of stairs. A second student timed how long it took her to go from the bottom to the top of the stairs. The height of the stairs was also measured.



(a) Complete the following sentence.

To run up the stairs the student must do work against

the force of _____ .

(1)

(b) The student did 2240 J of work going from the bottom of the stairs to the top of the stairs.

The student took 2.8 seconds to run up the stairs.

(i) Calculate the power the student developed when running up the stairs.

_____

_____

Power = _____ W

(2)

(ii) How much gravitational potential energy did the student gain in going from the bottom to the top of the stairs?

Tick (✓) **one** box.

much more than 2240 J ☐

2240 J ☐

much less than 2240 J ☐

(1)

(c) Another four students did the same experiment.

The measurements taken and the calculated values for power are given in the table.

Student	Weight in newtons	Time taken in seconds	Power in watts
A	285	3.8	240
B	360	2.4	480
C	600	3.4	560
D	725	4.0	580

(i) To make a fair comparison of their powers the students kept **one** variable in the experiment constant.

What variable did the students keep constant?

_____

(1)

(ii) From the data in the table a student wrote the following conclusion.

'The greater the weight of the student the greater the power developed.'

Suggest why this conclusion may **not** be true for a larger group of students.

_____

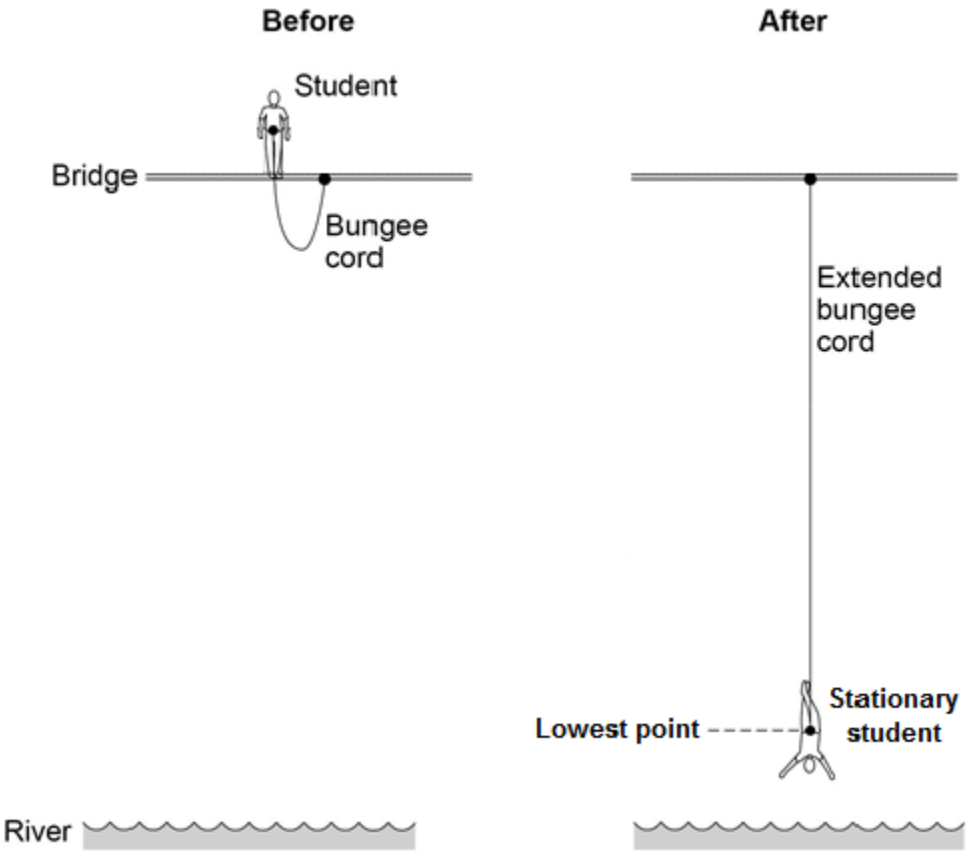
_____

(1)

(Total 6 marks)

2 The image below shows a student before and after a bungee jump.

The bungee cord has an unstretched length of 20 m.



(a) For safety reasons, it is important that the bungee cord used is appropriate for the student's weight.

Give **two** reasons why.

1. _____

_____

2. _____

_____

(2)

(b) The student jumps off the bridge.

Complete the sentences to describe the energy transfers.

Use answers from the box.

elastic potential	**gravitational potential**	**kinetic**	**sound**	**thermal**

Before the student jumps from the bridge he has a store of

_____ energy.

When he is falling, the student's store of _____

energy increases.

When the bungee cord is stretched, the cord stores energy as

_____ energy.

(3)

(c) At the lowest point in the jump when the student is stationary, the extension of the bungee cord is 35 metres.

The bungee cord behaves like a spring with a spring constant of 40 N / m.

Calculate the energy stored in the stretched bungee cord.

Use the correct equation from the Physics Equations Sheet.

_____

_____

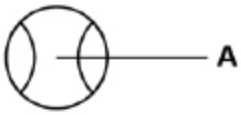
_____

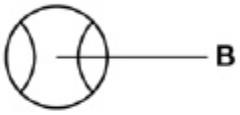
Energy = _____ J

(2)

(Total 7 marks)

3 The diagram shows a tennis ball thrown vertically into the air.





At position **C**, the ball has just left the tennis player's hand at a speed of 5.0 m/s

The tennis ball has a mass of 0.058 kg

(a) Write down the equation that links kinetic energy, mass and speed.

_____

(1)

(b) Calculate the kinetic energy of the tennis ball at position **C**.

_____

_____

Kinetic energy = _____ J

(2)

(c) At position **A** the tennis ball is at maximum height.

What is the gravitational potential energy of the tennis ball at position **A**?

Ignore the effect of air resistance.

_____

(1)

At position **B** the tennis ball has 0.38 J of gravitational potential energy.

(d) Write down the equation that links gravitational field strength, gravitational potential energy, height and mass.

_____

(1)

(e) Calculate the height of the tennis ball above the tennis player's hand when at position **B**.

gravitational field strength = 9.8 N/kg

_____

_____

_____

_____

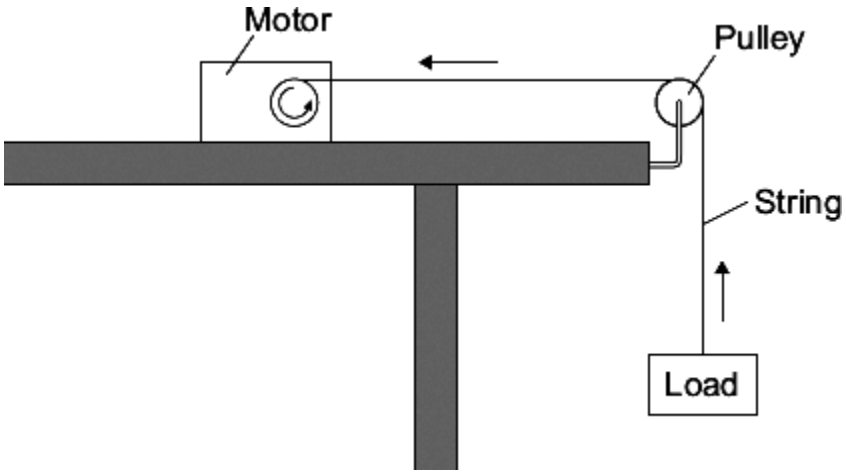
_____

Height = _____ m

(3)

(Total 8 marks)

4 A student uses an electric motor to lift a load.



In the motor, the electrical energy is transferred into other types of energy. Some of this energy is useful and the rest of the energy is wasted.

(a) (i) Name the useful energy output from the electric motor.

_____

(1)

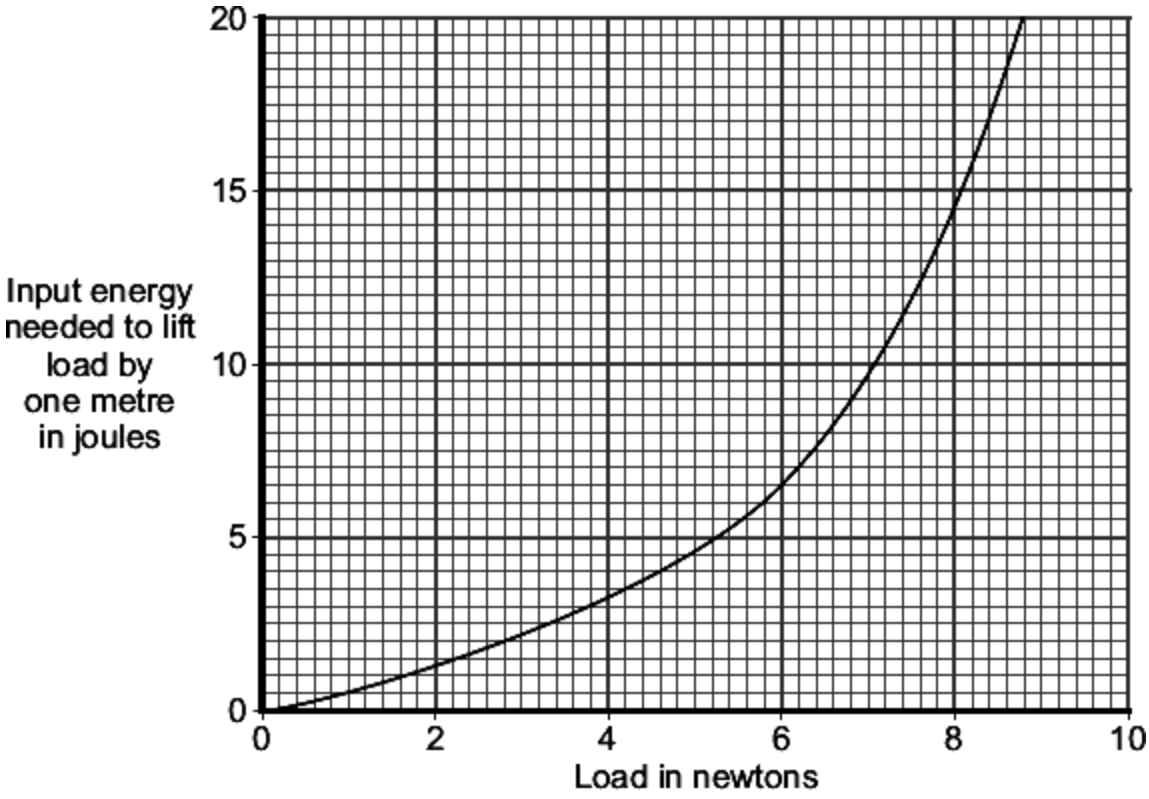
(ii) What eventually happens to the wasted energy?

_____

_____

(1)

(b) The graph shows the input energy the motor needs to lift different loads by one metre.



What can you conclude from the graph about the relationship between the load lifted and the input energy needed?

_____

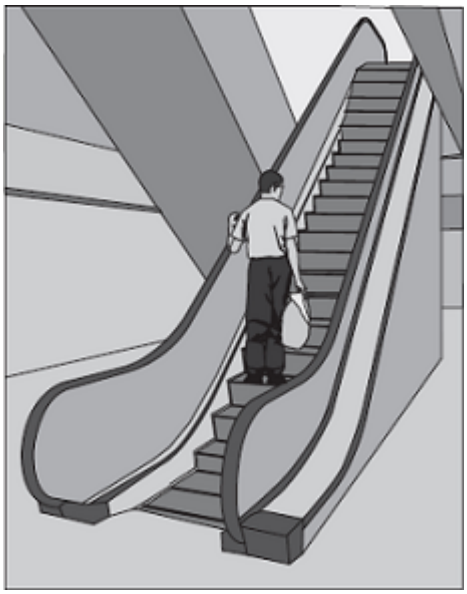
_____

_____

_____

(2)

(c) A shop uses escalators to lift customers to different floor levels. The escalators use electric motors. When the shop is not busy some escalators are turned off. A sign tells the customers that the escalators are turned off to save energy.



(i) Each escalator has one motor with an average power of 4000 W. The motor is turned on for an average of 8 hours each day, 6 days each week. Electricity costs 15 pence per kilowatt-hour.

Calculate the cost of the electricity used in an average week to run **one** escalator.

Show clearly how you work out your answer.

_____

_____

_____

_____

Cost = _____ pence

(3)

(ii) Give **one** environmental advantage to turning off electrical appliances when they are not being used.

_____

_____

(1)

(Total 8 marks)

5 The image shows a battery-powered drone.

(a) Complete the sentences.

Choose the answers from the box.

chemical	**elastic potential**	
gravitational potential	**kinetic**	**nuclear**

As the drone accelerates upwards

its _____ energy increases

and its _____ energy increases.

The _____ energy store

of the battery decreases.

(3)

(b) In the USA, drones are not allowed to be flown too high above the ground.

Suggest **one** possible risk of flying a drone too high above the ground.

_____

_____

_____

(2)

(c) Write down the equation that links energy transferred, power and time.

_____

(1)

(d) The drone can fly for 25 minutes before the battery needs recharging.

The power output of the battery is 65.0 W

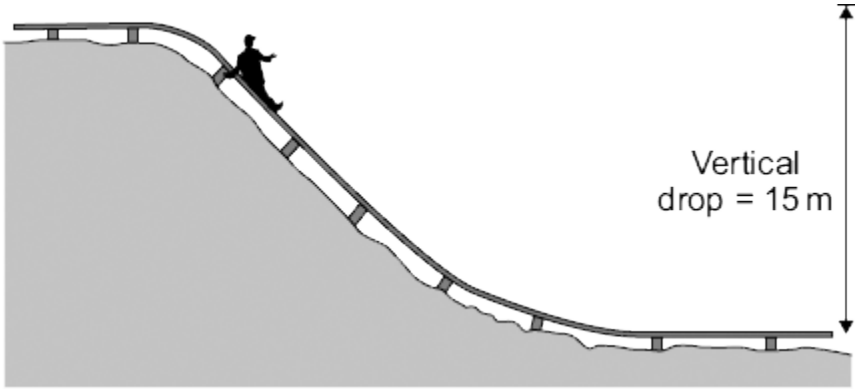
Calculate the maximum energy stored by the battery.

Maximum energy = _____ joules

(3)

(Total 8 marks)

6 The miners working in a salt mine use smooth wooden slides to move quickly from one level to another.



(a) A miner of mass 90 kg travels down the slide.

Calculate the change in gravitational potential energy of the miner when he moves 15 m vertically downwards.

gravitational field strength = 10 N/kg

Show clearly how you work out your answer.

Change in gravitational potential energy = _____ J

(2)

(b) Calculate the **maximum** possible speed that the miner could reach at the bottom of the slide.

Show clearly how you work out your answer.

Give your answer to an appropriate number of significant figures.

Maximum possible speed = _____ m/s

(3)

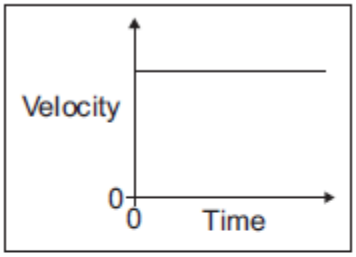
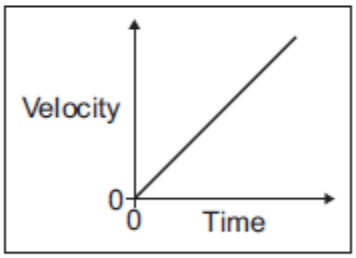
(c) The speed of the miner at the bottom of the slide is much less than the calculated maximum possible speed.

Explain why.

(3)

(Total 8 marks)

7 (a) Draw **one** line from each velocity–time graph to the statement describing the motion shown by the graph.

Velocity–time graph	Motion shown by graph
	Constant acceleration
	Not moving
	Constant deceleration
	Constant velocity

(2)

(b) Use the correct answer from the box to complete the sentence.

energy	**momentum**	**speed**

The velocity of an object includes both the _____ of the object and the direction the object is moving.

(1)

(c) At the start of a race, a horse accelerates from a velocity of 0 m/s to a velocity of 9 m/s in 4 seconds.

(i) Calculate the acceleration of the horse.

_____

_____

Acceleration = _____ m/s^2

(2)

(ii) When the horse accelerates, what, if anything, happens to the air resistance acting against the horse?

Tick (✓) **one** box.

The air resistance decreases ☐

The air resistance is constant ☐

The air resistance increases ☐

(1)

(d) A horse and a pony walk across a field at the same constant speed.

The horse has 4000 joules of kinetic energy.

The pony is **half** the mass of the horse.

What is the kinetic energy of the pony?

Draw a ring around the correct answer

2000 J **4000 J** **8000 J**

Give a reason for your answer.

_____

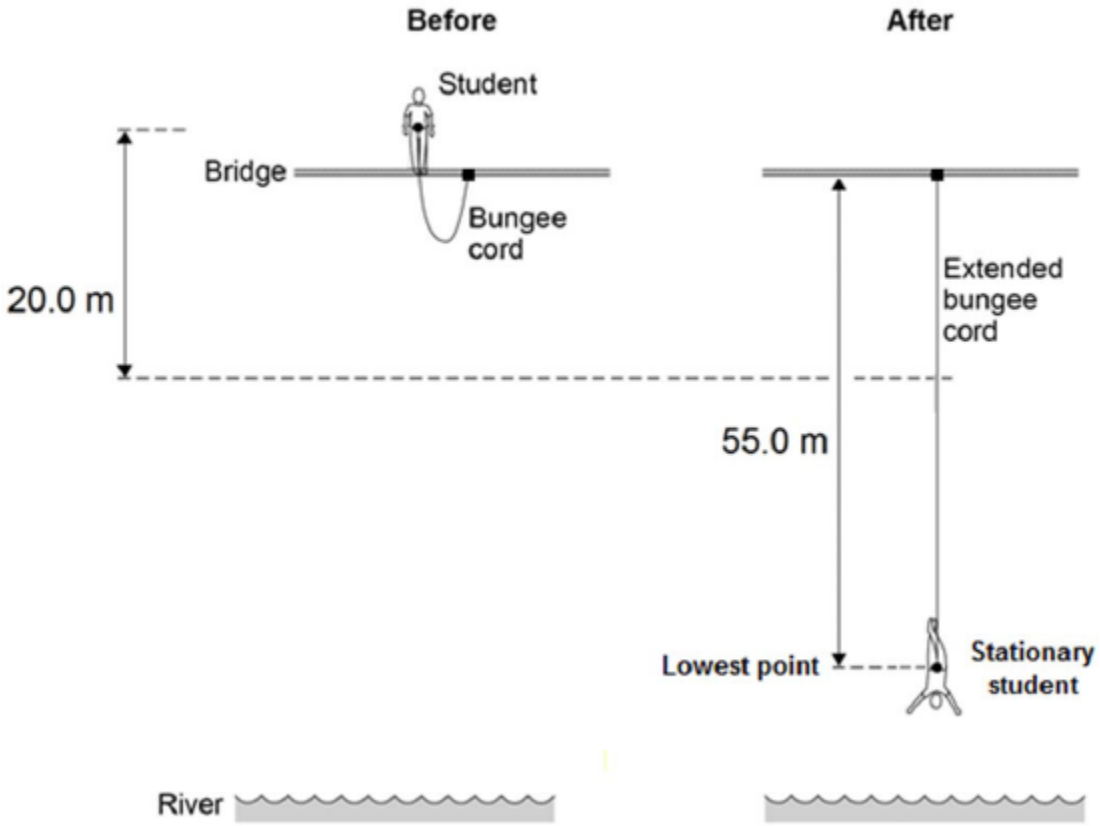
_____

(2)

(Total 8 marks)

8 The figure below shows a student before and after a bungee jump.

The bungee cord has an unstretched length of 20.0 m.



The mass of the student is 50.0 kg.

The gravitational field strength is 9.8 N / kg.

(a) Write down the equation which links gravitational field strength, gravitational potential energy, height and mass.

_____

(1)

(b) Calculate the change in gravitational potential energy from the position where the student jumps to the point 20.0 m below.

_____

_____

_____

Change in gravitational potential energy = _____ J

(2)

(c) 80% of this change in gravitational potential energy has been transferred to the student's kinetic energy store.

How much has the student's kinetic energy store increased after falling 20.0 m?

Kinetic energy gained = _____ J

(1)

(d) Calculate the speed of the student after falling 20.0 m.

Give your answer to two significant figures.

_____

_____

_____

_____

Speed = _____ m / s

(4)

(e) At the lowest point in the jump, the energy stored by the stretched bungee cord is 24.5 kJ.

The bungee cord behaves like a spring.

Calculate the spring constant of the bungee cord.

Use the correct equation from the Physics Equation Sheet.

_____

_____

_____

_____

_____

_____

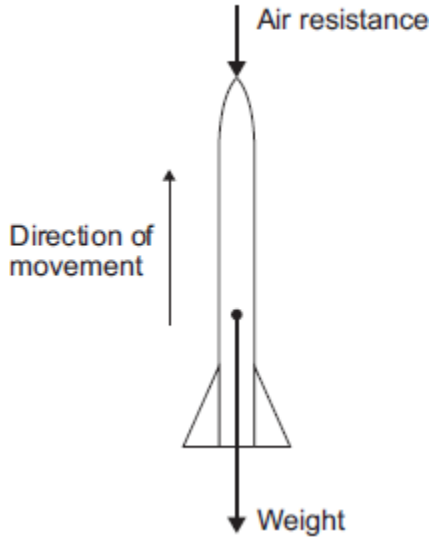
Spring constant = _____ N / m

(3)

(Total 11 marks)

9 (a) **Figure 1** shows the forces acting on a model air-powered rocket just after it has been launched vertically upwards.

Figure 1



(i) How does the velocity of the rocket change as the rocket moves **upwards**?

_____

Give a reason for your answer.

_____

_____

(2)

(ii) The velocity of the rocket is not the same as the speed of the rocket.

What is the difference between the velocity of an object and the speed of an object?

_____

_____

_____

(1)

(b) The speed of the rocket just after being launched is 12 m / s.
The mass of the rocket is 0.05 kg.

(i) Calculate the kinetic energy of the rocket just after being launched.

_____

_____

_____

Kinetic energy = _____ J

(2)

(ii) As the rocket moves upwards, it gains gravitational potential energy.

State the maximum gravitational potential energy gained by the rocket.

Ignore the effect of air resistance.

Maximum gravitational potential energy = _____ J

(1)

(iii) Calculate the maximum height the rocket will reach.

Ignore the effect of air resistance.

Gravitational field strength = 10 N/kg.

_____

_____

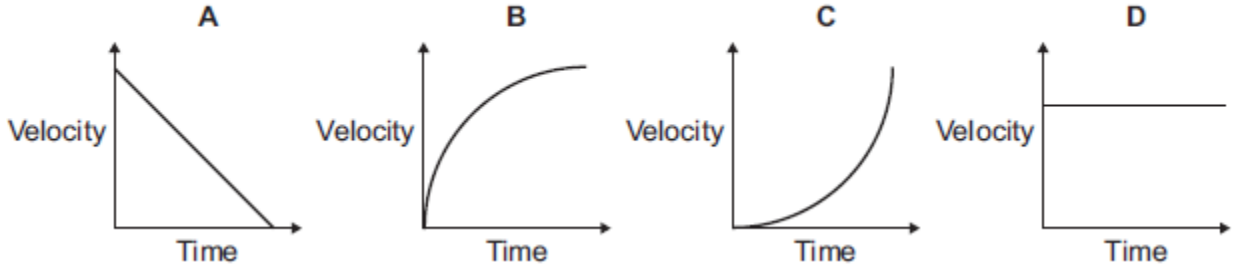
_____

Maximum height = _____ m

(2)

(iv) **Figure 2** shows four velocity−time graphs.

Figure 2



Taking air resistance into account, which graph, **A**, **B**, **C** or **D**, shows how the velocity of the rocket changes as it **falls** from the maximum height it reached until it just hits the ground?

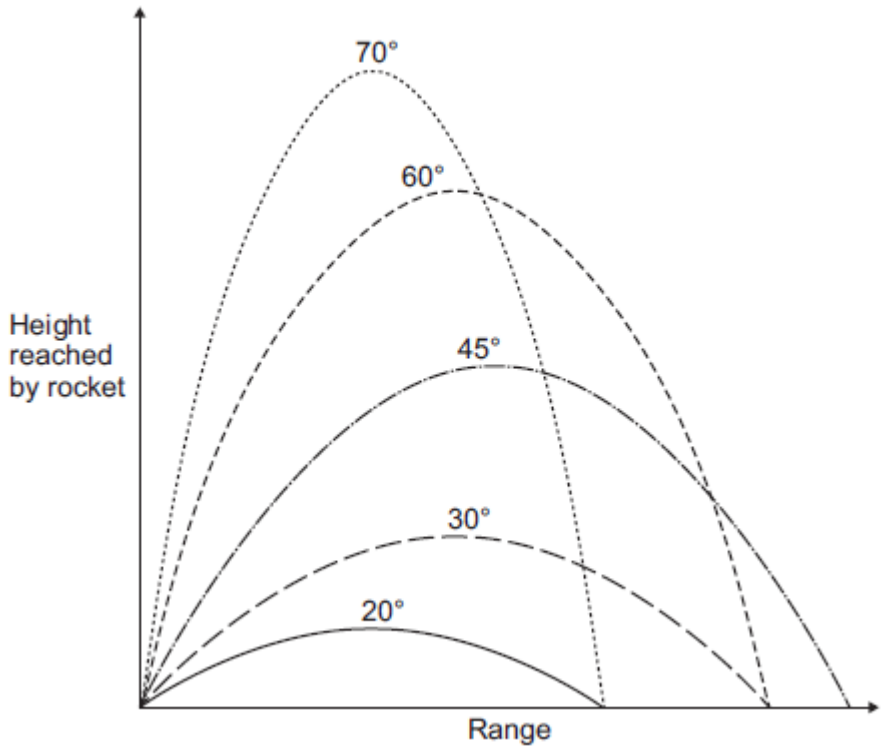
Write the correct answer in the box. ☐

(1)

(c) The rocket can be launched at different angles to the horizontal.
The horizontal distance the rocket travels is called the range.

Figure 3 shows the paths taken by the rocket when launched at different angles.
Air resistance has been ignored.

Figure 3



What pattern links the angle at which the rocket is launched and the range of the rocket?

_____

_____

_____

_____

(2)

(Total 11 marks)