2.3 Work, Energy & Power

Question Paper

Course	DP IB Physics
Section	2. Mechanics
Topic	2.3 Work, Energy & Power
Difficulty	Easy

Time allowed: 80

Score: /64

Percentage: /100

Question 1a

A toy company are investigating the workings behind several types of toys.

(a)
Select, by placing a tick (✔) in the correct box, the main form of energy used by each toy.

Toy	Kinetic Energy	Gravitational Potential Energy	Elastic Potential Energy
A catapult			
An action figure falling using a parachute			
A wind-up bouncing rabbit			
A train moving along a train track			

[4]

[4 marks]

Question 1b

The catapult from part (a) is undergoing testing. The spring constant of the elastic band in the catapult is 92 N m^{-1}. In one test the band is extended by 0.3 m.

(b)
Calculate the elastic potential energy stored in the elastic band of the catapult.

[2]

[2 marks]

Question 1c

An action figure from part (a) of mass 250 g is dropped from a height of 5 m.

(c)
Calculate the gravitational potential energy of the action figure in this experiment.

[3]

[3 marks]

Question 1d

A new type of pushchair for dolls is being developed. In one round of testing a pushchair has a force of 20 N applied for a distance of 5 m at an angle of 45° to the horizontal.

(d)
Calculate the work done on the pushchair.

[2]

[2 marks]

Question 2a

At an athletics training camp, runners are being tested for their speed, efficiency and power. A runner with a mass of 52 kg manages to maintain a constant velocity of 7 m s^{-1}.

(a)
Calculate the kinetic energy of the runner.

[2]

[2 marks]

Question 2b

The runner from part (a) runs for 12 seconds.

(b)
Calculate her power.

[3]

[3 marks]

Question 2c

At the training camp runners are kept on a strict diet to maximise performance.

(c)
Identify the following types of energy:

(i)
The energy stored in the athlete's muscles.

[1]

(ii)
Two forms of wasted energy transfer produced from the stored energy above.

[2]

[3 marks]

Question 2d

Runners are also analysed for their efficiency. The same runner from parts (a) and (b) eats an energy bar that provides 800 000 J of energy.

(d)
Calculate the efficiency of her run assuming that all the energy from the bar is transferred to her body for use on the run.

[2]

[2 marks]

Question 3a

The rising price of petrol is inspiring car companies to produce more efficient electric models.

(a)
Identify by placing a tick (✔) in the correct boxes the useful and wasted energy transferred from the chemical reaction happening inside a petrol car.

Energy type	Useful	Wasted
Sound		
Thermal		
Electrical		
Kinetic		

[4]

[4 marks]

Question 3b

Some energy within a system is stored and some is transferred.

(b)
Place a tick (✔) in the correct box to identify whether the following energy types are stores or transfers.

Energy type	Transfer	Store
Chemical		
Nuclear		
Sound		
Light		
Kinetic		
Internal		
Elastic		
Gravitational potential		
Electrical		

[9]

[9 marks]

Question 3c

Driving safety organisations are worried that electric cars are more powerful than petrol or diesel cars causing them to be very dangerous.

In a test drive, the thrust from an electric car engine is 200 N when the car maintains a constant speed of 27 m s^{-1}.

(c)
Calculate the power of the car.

[2]

[2 marks]

Question 3d

(d)
State:

(i)
Whether electric or petrol cars have more wasted energy.

[1]

(ii)
Two types of wasted energy in a car energy system.

[2]

[3 marks]

Question 4a

Astronauts are in training for a planned mission to land on the surface of Jupiter.

(a)
Identify, by placing a tick (✔) in the box(es), which of the following tasks will be more difficult to carry out due to the larger acceleration of free fall on Jupiter.

Task	More difficult
Throwing a ball up from the surface	
Driving a car along the surface	
Stretching a spring whilst setting up a tent	
Launching a rocket from the surface	

[2]

[2 marks]

Question 4b

A ball is dropped from a height of 2 m towards the surface of Jupiter. The acceleration of free fall on Jupiter is 24.58 m s^{-2}.

(b)
Calculate the speed of the ball just as it hits the surface. Assume that no energy is lost to the surroundings.

(i)
State the relationship, in symbols, between gravitational potential energy at the point the ball is dropped from and the kinetic energy just before it hits the surface

[1]

(ii)
Rearrange the relationship found in part (i) to obtain an equation for *v*, the speed of the ball when it hits the surface

[1]

(iii)
Hence, calculate *v*

[1]

[3 marks]

Question 4c

The mass of the rocket upon its launch from Jupiter is 18×10^6 kg. It takes 300 seconds to travel the 3000 km to the edge of Jupiter's atmosphere.

(c)
Calculate:

(i)
The weight of the rocket.

[2]

(ii)
The minimum power required by the rocket to leave the surface of Jupiter.

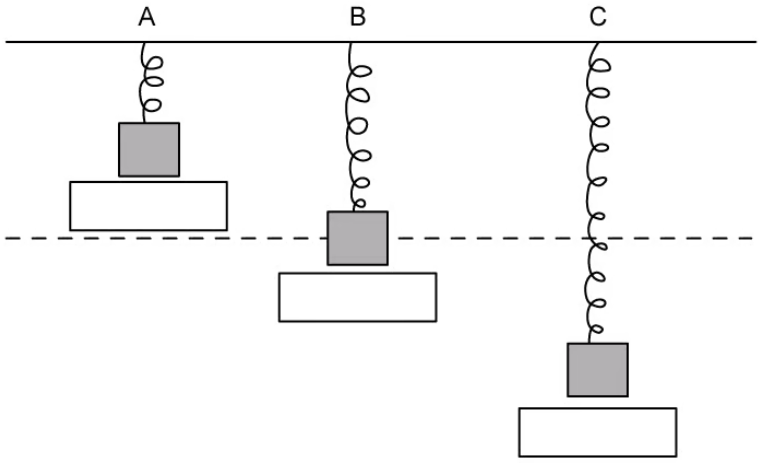
[3]

[5 marks]

Question 4d

Astronauts have developed special tents with stiff springs to erect on the surface of Jupiter. The springs hang freely vertically with one end fixed to the tent and the other with a mass secured.

(d)
Label the diagram below to show the spring when the gravitational potential energy (ΔE_p), kinetic energy (E_k) and elastic potential energy (E_p) are each at their maximum.



[3]

[3 marks]

Question 5a

A violin maker is conducting materials testing on various new strings. The first string has a spring constant of 23 000 N m^{-1} and is extended by 0.06 m before it breaks.

(a)
Calculate the force applied to the string just before it breaks.

[3]

[3 marks]

Question 5b

The string has a mass of 1.97×10^{-4} kg. When the string breaks, assume all elastic potential energy is transferred to kinetic energy.

(b)
Calculate the speed of the string upon breaking.

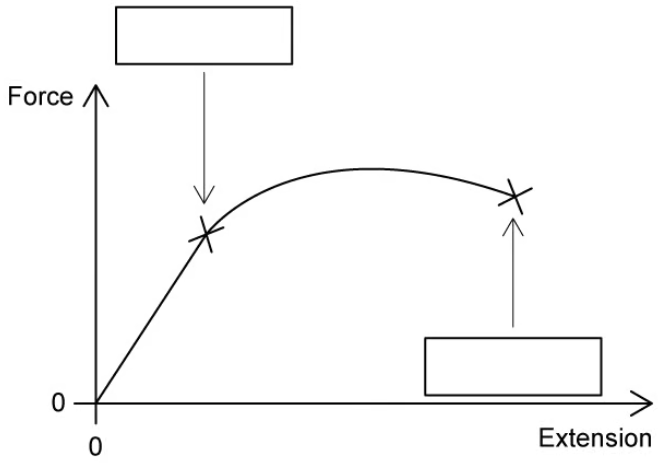
[4]

[4 marks]

Question 5c

The force-extension graph of a different string is shown below.

(c)
Identify the elastic limit and breaking point by labelling the graph.



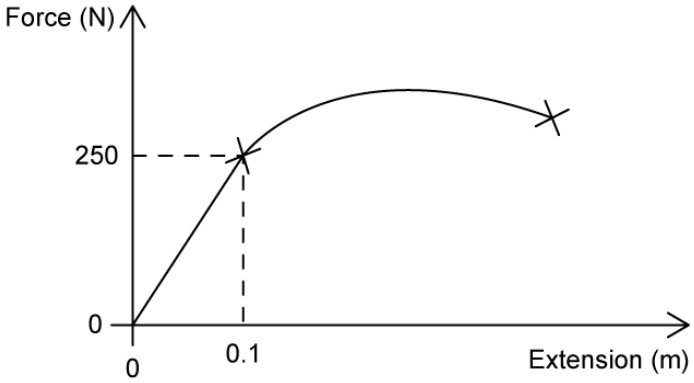
[2]

[2 marks]

Question 5d

(d)

Calculate the work done on the string up to the elastic limit.



[3]

[3 marks]