Question 13 (11 marks)

Horses can perform work for farming activities. In the past, they were used to loosen the soil before planting. Physics can be used to explore the ways in which horses complete these tasks.

Question 13a (2 marks)

A horse covers a distance of 3 km in 45 minutes. Calculate its speed in km per hour (kmh^{-1}).

Question 13b (1 mark)

Power is the rate of transforming energy or the rate of doing work. Select the formula for energy transformed.

- A. energy transformed = power x distance
- B. energy transformed = power ÷ distance
- C. energy transformed = power x time
- D. energy transformed = power ÷ time

Question 13c (2 marks)

The table below gives some data about two horses A and B. Calculate the missing values and complete the table. You should assume the value of g = 10 N kg^{-1}.

Horse	Mass of horse/kg	Weight/N
A	350	
B		5100

Question 13d (1 mark)

Select the correct terms to complete the energy transformation diagram for a horse that starts from rest at the bottom of a hill, runs up the hill and then stops at the top of the hill.

Draggable items:

Chemical potential energy	Gravitational potential energy
Elastic potential energy	Electrical Energy

⟶ Kinetic energy ⟶

Question 13e (3 marks)

The hill in part (d) is 12 m high. Horse B reaches the top of the hill in 5.50 s. Use information from part (c) and the formula sheet to calculate the minimum power required for horse B to reach this height. You should give your answer in kW.

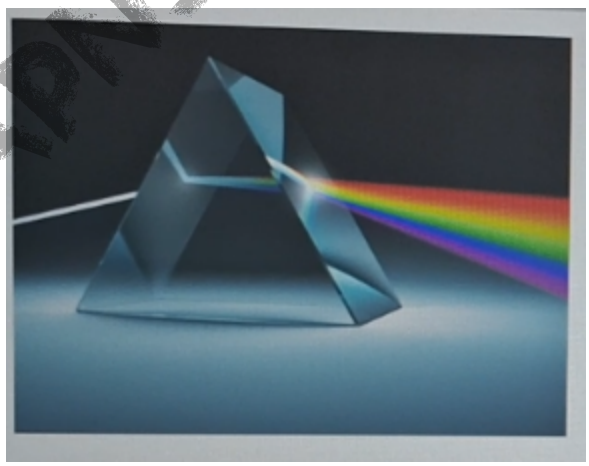
Question 13f (2 marks)

The power of some modern devices is given in horsepower (hp), where 1.0 hp is equivalent to 746 W. An example of such a device is an electric water pump. Calculate the current that would be needed by a water pump with a power of 2.0 hp operating at a voltage of 230 V.

Question 14 (7 mark)

Question 14a (1 mark)

The image shows white light being separated into different colours. Select the term for this process.



A. Absorption
B. Deflection
C. Reflection
D. Dispersion

Question 14b (3 marks)

Explain why red light is at the top of the image in part (a). You should use scientific terminology in your answer.

Question 14c (1 mark)

Another scientist called Herschel detected infrared waves beyond the visible spectrum. Unlike red light, infrared waves are not visible to the human eye. State one other difference between infrared waves and red light.

Question 14d (2 marks)

In air, all the colours of light in the spectrum travel at a speed of 3.00×10^8 m^{-1}. Use the formula sheet to calculate the frequency of red light with a wavelength of 750 nm. You should use scientific notation in your answer.

Question 15 (13 marks)

The pressure, volume and temperature of a gas are related. The ideal gas law describes the relationship between them. Gas is all around us in the form of air.

A student decides to investigate the effect of adding masses on the volume of air in a syringe. The student adds the masses slowly so that the temperature of the air in the syringe remains constant, as shown in the animation below.

Script

The tip of the syringe is sealed so that the amount of air is constant.

Masses are added and the plunger is pushed downwards, compressing the air in the syringe.

Question 15a (1 mark)

State the research question that could be answered in this scientific investigation.

Question 15b (2 marks)

Identify the variables for this investigation.

Variable	Independent	Dependent	Control
Amount of air in the syringe	☐	☐	☐
Mass added to plunger	☐	☐	☐
Size of syringe	☐	☐	☐
Temperature	☐	☐	☐
Volume of air	☐	☐	☐

Question 15c (1 mark)

Write the correct response to complete the sentence.

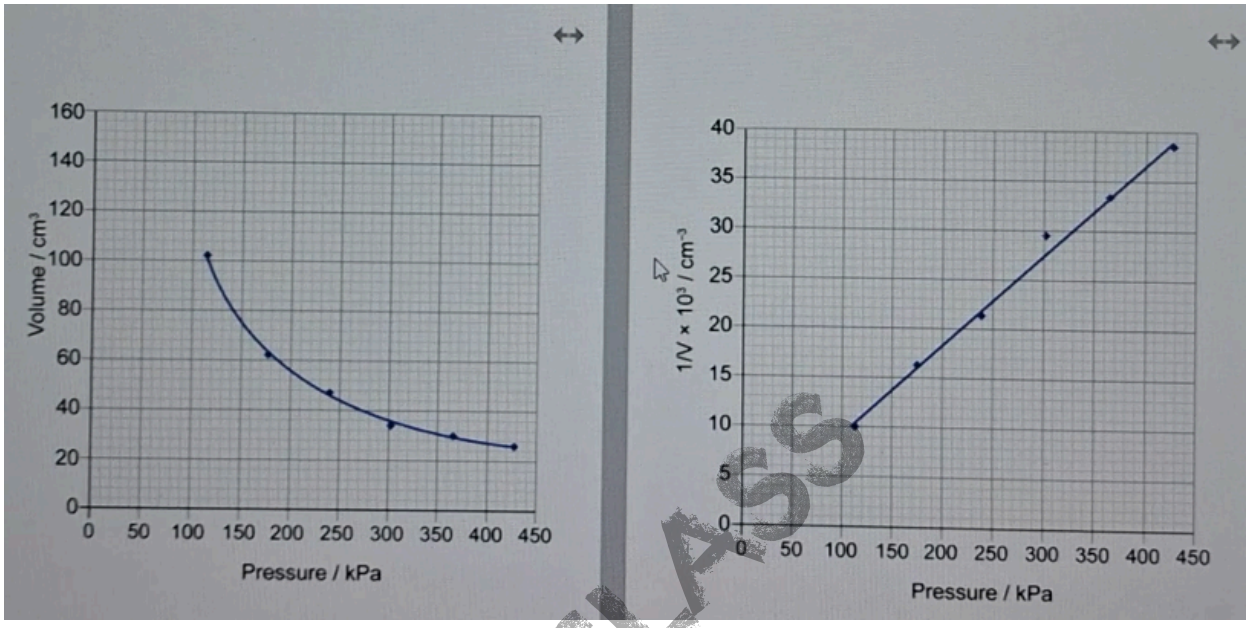
When masses are added to the plunger, the pressure will _____ .

Question 15d (3 marks)

The plunger has an area of $7.9 \times 10^{-5} m^2$. Atmospheric pressure is 100 000 Pa. Use the formula sheet to calculate the total pressure on the air in the syringe if the mass applied is 1.2 kg. You should assume that the value of $g = 10\ Nkg^{-1}$.

Question 15e (2 marks)

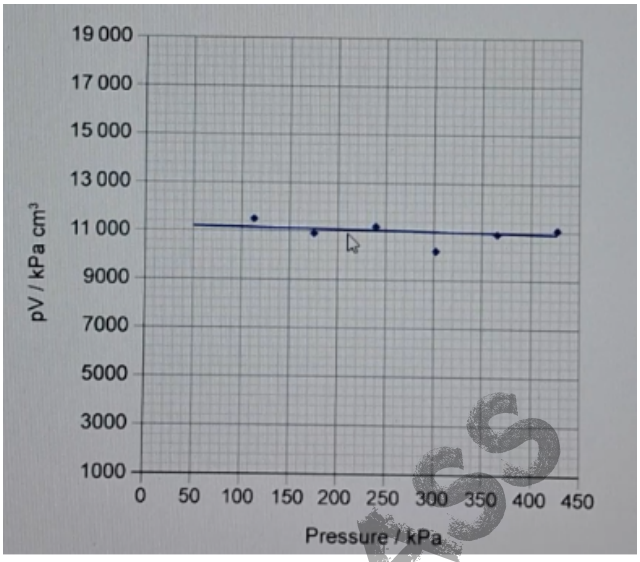
The student calculated the total pressure for each of the masses used. She presented the processed data in the graphs below.



Use both graphs above to describe the relationship between pressure and volume of a gas.

Question 15f (2 marks)

Another student decided to multiply pressure by volume (pV) and presented this on the graph below.



Boyle's law states that pV is constant for a fixed amount of gas at constant temperature.
Suggest whether the graph supports Boyle's law. Justify your answer.

Question 15g (2 marks)

Use the graph in part (f) to calculate the volume of gas when the pressure is 75 kPa. You should include a unit in your answer.