BENENDEN

PHYSICS

Sixth Form Entrance Examination 2021

Time: *1 hour 30 minutes*

Full Name:…………………………………………………………………

Current School:…………………………………………………………

Date:……………………………………………………………………………

Instructions to Candidates:

- Write all your answers in this booklet
- Calculators may be used
- The number of marks available is shown on each question
- Total marks for this paper = 100 marks

Questions

Q1.

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

(Total for question = 1 mark)

Q2.

Explain, with the aid of a circuit diagram, the method a student could use to investigate how the resistance of a single lamp changes with the potential difference across the lamp.

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(Total for question = 6 marks)

Q3.

A cyclist is riding a bicycle at a steady velocity of 12 m/s.

The cyclist and bicycle have a total mass of 68 kg.

A class of students investigate the power output of each student in the class.

The class must decide whether they use a method using steps or a method using weights.
The whole class must use the same method.

Plan what measurements the students should take and how these can be used to calculate and compare the power output of each student.

You may draw a diagram to help with your plan.

(6)

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(Total for question = 6 marks)

Q4.

A student investigates what happens when light travels from air to glass.

Figure 15 shows some of the apparatus used in the investigation.

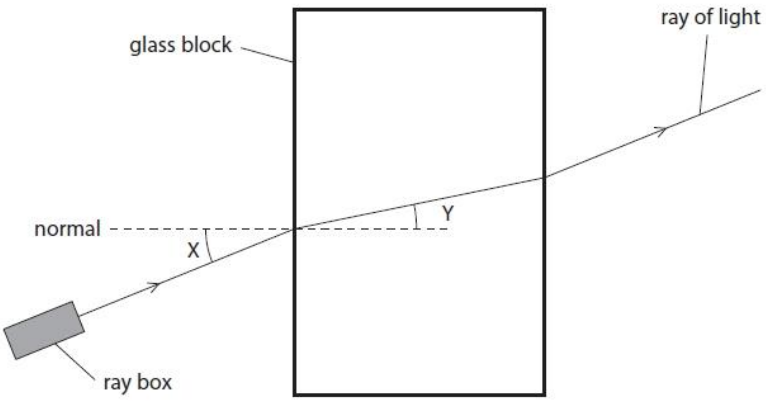

Figure 15

(i) In Figure 15, angle Y is the angle of

(1)

☐ **A** deflection
☐ **B** incidence
☐ **C** reflection
☐ **D** refraction

(ii) Figure 16 is a graph of the student's results.

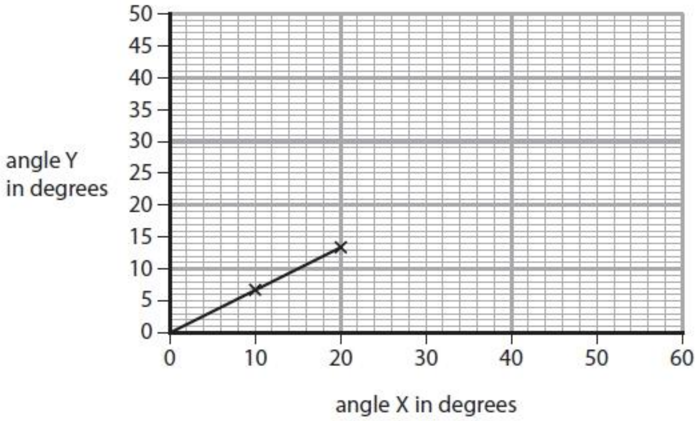

Figure 16

Use the graph to calculate a value for

$$\frac{\text{angle Y}}{\text{angle X}}$$

(2)

$\frac{\text{angle Y}}{\text{angle X}}$ = ...

(iii) The student concludes that angle Y is directly proportional to angle X.

Explain what the student must do to test this conclusion in more detail.

(3)

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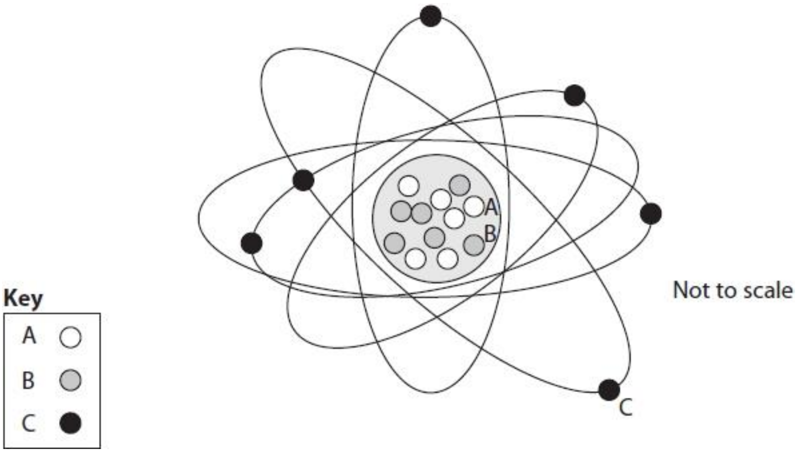
(Total for question = 6 marks)

Q5.

The diagram shows an atom of carbon.

A, B and C are three different particles.



(i) Name the three different particles shown.

(3)

A = ...

B = ...

C = ...

(ii) What is the mass (nucleon) number of this carbon atom?

(1)

....

(Total for question = 4 marks)

Q6.

Figure 2 shows an energy transfer diagram for a steam engine.

The diagram shows the amounts of energy transferred each second by the steam engine.

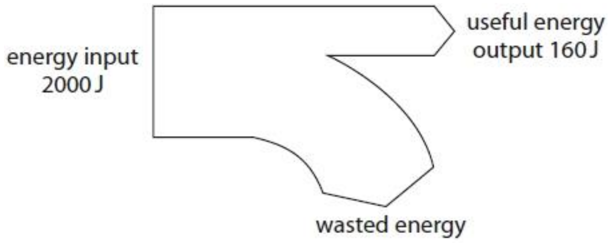


Figure 2

(i) Calculate the amount of wasted energy.

(1)

wasted energy = ... J

(ii) Calculate the efficiency of the steam engine.

Use the equation

$$\text{efficiency} = \frac{\text{(useful energy transferred by the steam engine)}}{\text{(total energy supplied to the steam engine)}}$$

(2)

efficiency = ...

(iii) State what happens to the wasted energy.

(1)

....

....

(iv) Coal is a fossil fuel that is burnt in some steam engines.

State **two** ways that the use of coal might be harmful to the environment.

(2)

1 ....

....

2 ....

....

(Total for question = 6 marks)

Q7.

Shot-put is an Olympic event.
The shot is a heavy ball.
An athlete throws the shot as far as possible.

A sports scientist analyses an athlete's throw to help improve performance.

In one throw, the shot continues to rise by another 1.3 m after it leaves the athlete's hand.
The mass of the shot is 7.26 kg.

Calculate the amount of gravitational potential energy gained by the shot.

(2)

gravitational potential energy gained = ... J

(Total for question = 2 marks)

Q8.

An electric heater is connected to a 230 V supply.

The power supplied to the heater is 2.6 kW.

Calculate the current in the heater.

(3)

current = ... A

(Total for question = 3 marks)

Q9.

A cyclist is riding a bicycle at a steady velocity of 12 m/s.

The cyclist and bicycle have a total mass of 68 kg.

The cyclist starts to cycle again.

The cyclist does 1600 J of useful work to travel 28 m.

Calculate the average force the cyclist exerts.

(3)

average force = ... N

(Total for question = 3 marks)

Q10.

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.

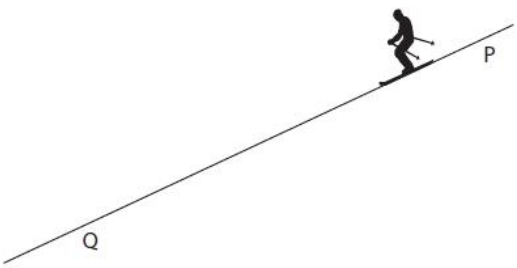


Figure 12

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

acceleration	3.0 m/s^2
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)

distance from P to Q = ... m

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

(3)

time from P to Q = ... s

(Total for question = 6 marks)

Q11.

A scuba diver goes for a dive. When underwater, the diver tries to move a large stone block.

The diver uses a long iron bar and a pivot, as shown in Figure 26.

When pushing down with a force of 120 N, the block is balanced.

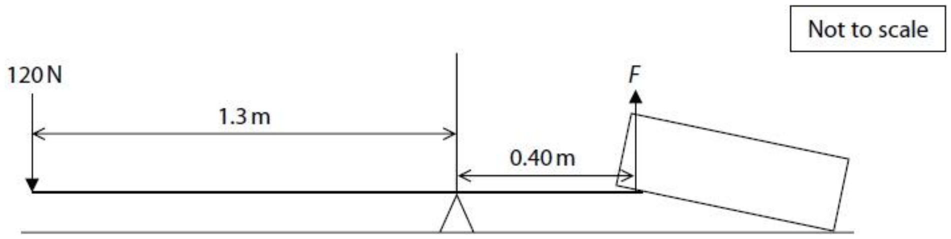


Figure 26

Calculate the size of the force, *F*, of the bar on the block.

(3)

force = ... N

(Total for question = 3 marks)

Q12.

A weight of 4.0 N is used to extend a spring.
The extension of the spring is 0.06 m.

(i) Calculate the spring constant, *k*, of the spring.

Use the equation

$$F = k \times x$$

(3)

spring constant = ... N/m

(ii) State what measurements should be made to determine the extension of the spring produced by the 4.0 N weight.

(2)

....

....

....

....

(Total for question = 5 marks)

Q13.

A sound wave travels with a velocity of 1530 m/s.

The frequency of the wave is 1.20 kHz.

Calculate the wavelength of the wave.

(3)

wavelength = ... m

(Total for question = 3 marks)

Q14.

Figure 13 shows a tank for holding water.

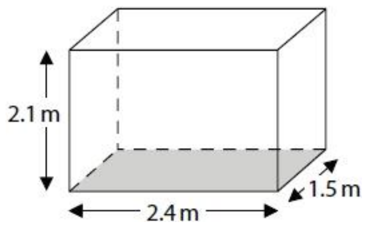


Figure 13

The tank has sides of 2.4 m, 2.1 m and 1.5 m.

The pressure at the bottom of the tank is 12 kPa.

(i) State the equation relating pressure, force and area.

(1)

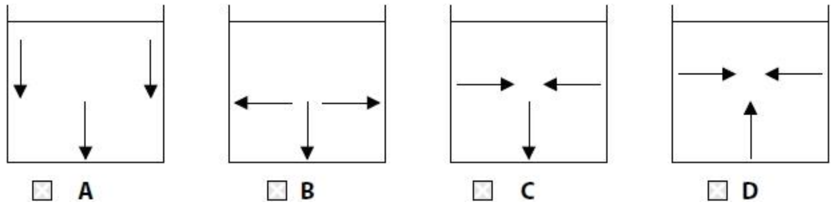
(ii) Calculate the weight of water in the tank.

(4)

weight = ... N

(iii) Which diagram shows the direction of the forces from the water on the inside of the tank?

(1)



(Total for question = 6 marks)

Q15.

Figure 1 is a table showing the distance from the Sun of the orbit of some planets.

The distances are in AU (astronomical units).

1 AU = 150 000 000 km

planet	distance of orbit from the Sun in AU
Mercury	0.39
Earth	1
Mars	1.5
Jupiter	5.2
Neptune	30.1

Figure 1

(i) State the distance of Earth from the Sun in kilometres.

(1)

distance of Earth from the Sun = ... km

(ii) One of the planets in the table orbits the Sun between the orbits of Earth and Jupiter.

Calculate the distance from the Sun to this planet in kilometres.

(2)

distance from the Sun = ... km

(Total for question = 3 marks)

Q16.

The International Space Station (ISS) has several solar panels called wings.

(a) The wings convert energy from the Sun into a form useful in the ISS.

(1)

- ☐ **A** transverse and electromagnetic
- ☐ **B** electromagnetic but not transverse
- ☐ **C** transverse but not electromagnetic
- ☐ **D** neither transverse nor electromagnetic

(b) In one second, the useful energy available from one wing is 34.3 kJ.
The energy incident on the wing from the Sun is five times this amount.

What is the percentage efficiency of the wing?

(3)

efficiency = ... %

(c) A wing is in direct sunlight.
The ISS is not receiving energy from the wing.
The temperature of the wing remains constant.

Explain why the temperature of the wing remains constant in these conditions.

(2)

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(Total for question = 6 marks)

Q17.

This photograph shows a fan.

The blades of the fan are turned by an electric motor.

In one second, the motor gets 200 J of electrical energy from the mains supply.
Only 180 J of this energy is used to turn the blades of the fan.

The rest of the energy is wasted.

(i) Calculate how much of the 200 J of energy is wasted.

(1)

wasted energy = ... J

(ii) State what happens to the wasted energy.

(1)

....

....

(iii) Calculate the efficiency of the motor.

(2)

efficiency = ...

(Total for question = 4 marks)

Q18.

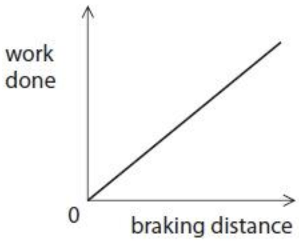
Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

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

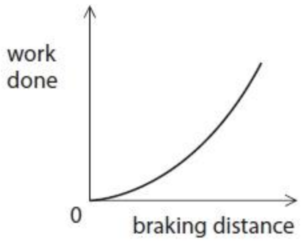
work done = braking force × braking distance

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

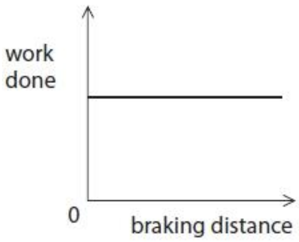
(1)



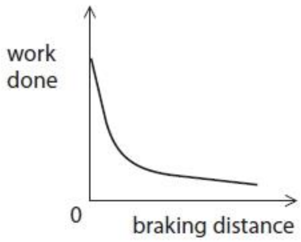
☒ **A**



☒ **B**



☒ **C**



☒ **D**

(Total for question = 1 mark)

Q19.

(i) State the name of an instrument that can be used to measure radioactivity.

(1)

....

(ii) State **two** sources of background radiation.

(2)

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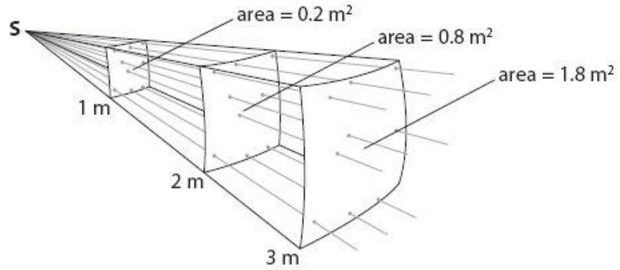
2 ....

(Total for question = 3 marks)

Q20.

The diagram shows light from a point source, **S**, spreading out as it gets further from **S**.



(a) The intensity of light passing through the surface which is 1 m from **S** is 2.5 W/m^2.

(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

The intensity of light, in W/m^2, passing through the surface which is 2 m from **S** is

(1)

☐ **A** 2.5 ÷ 2

☐ **B** 2.5 ÷ 4

☐ **C** 2.5 × 2

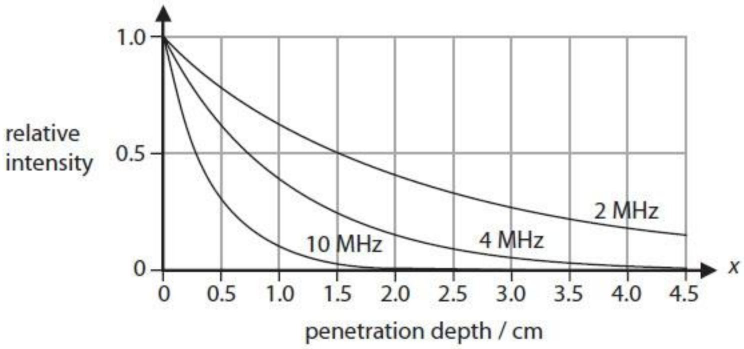
☐ **D** 2.5 × 4

(ii) Calculate the power of the light passing through the surface which is 1m from **S**.

(2)

....

(b) The graph shows how the intensity of ultrasound waves of different frequencies decreases as they penetrate soft tissue.



(i) Estimate how far a 2 MHz wave has penetrated into the soft tissue when its intensity is 25% of its original value.

(1)

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(ii) Explain which of these frequencies of ultrasound can be used to scan organs deep inside the body.

(2)

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(c) Medical physicists have developed endoscopes and many other devices to help doctors diagnose medical problems.

Compare the use of electromagnetic radiation in endoscopes and in one other diagnostic device.

(6)

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(Total for Question = 12 marks)

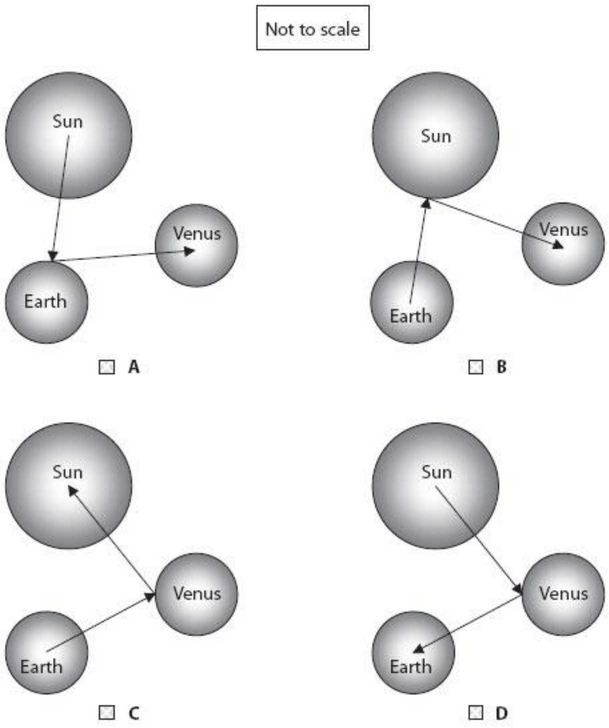
Q21.

(a) Galileo was one of the first scientists to use a telescope to study Venus.

(i) Which of these diagrams best shows how light waves enable us to see Venus?

Put a cross ( ) in the box next to your answer.

(1)



(ii) Use words from the box to complete the sentences.

(2)

asteroids	comets	geocentric	heliocentric
moons	particle	stars	

Galileo also used his telescope to observe the .... of Jupiter.
His observations provided evidence to support the .... model of the Solar System.

(iii) Describe how a reflecting telescope is different from the simple telescope which Galileo used.

(2)

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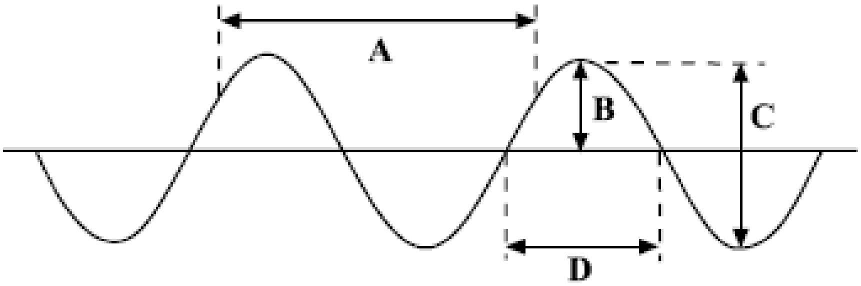
(b) (i) The diagram represents a wave.



State the amplitude and wavelength of the wave.

(2)

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....

(ii) 20 waves are sent out in 4 seconds.

Complete the sentence by putting a cross ( ) in the box next to your answer.

The frequency of the wave is

(1)

☒ **A** 0.2 Hz

☒ **B** 5 Hz

☒ **C** 20 Hz

☒ **D** 80 Hz

(Total for Question is 8 marks)

Q22.

A light wave from a star has a frequency of 6.67×10^{14} Hz and a wavelength of 4.50×10^{-7} m.

The star is 4.00×10^{16} m away from Earth.

Calculate the time it takes light from the star to reach the Earth.

(3)

time to reach Earth = ... s

(Total for question = 3 marks)

END OF PAPER

Turn over for Formulae

FORMULAE

You may find the following formulae useful.

energy transferred = current × voltage × time $E = I \times V \times t$

$$\text{frequency} = \frac{1}{\text{time period}} \qquad f = \frac{1}{T}$$

$$\text{power} = \frac{\text{work done}}{\text{time taken}} \qquad P = \frac{W}{t}$$

$$\text{power} = \frac{\text{energy transferred}}{\text{time taken}} \qquad P = \frac{W}{t}$$

$$\text{orbital speed} = \frac{2\pi \times \text{orbital radius}}{\text{time period}} \qquad v = \frac{2 \times \pi \times r}{T}$$

$(\text{final speed})^2 = (\text{initial speed})^2 + (2 \times \text{acceleration} \times \text{distance moved})$

$$v^2 = u^2 + (2 \times a \times s)$$

pressure × volume = constant $p_1 \times V_1 = p_2 \times V_2$

$$\frac{\text{pressure}}{\text{temperature}} = \text{constant} \qquad \frac{p_1}{T_1} = \frac{p_2}{T_2}$$

Where necessary, assume the acceleration of free fall, $g = 10\ \text{m/s}^2$.