Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | | | | | |

Candidate Number | | | | |

Physics

Advanced
Paper 2: Advanced Physics II

Sample Assessment Materials for first teaching September 2015

Time: 1 hour 45 minutes

Paper Reference **9PH0/02**

You may need the Formulae Sheet, a ruler and a calculator.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You may use a scientific calculator.

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an *****, marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- You are advised to show your working in calculations including units where appropriate.

Turn over ▶

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S 4 7 5 5 9 A 0 1 2 8

PEARSON

Answer ALL questions.

All multiple choice questions must be answered with a cross ☒ in the box for the correct answer from A to D. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 A diverging lens is used to produce an image of a real object.

Select the row of the table that correctly identifies the nature of the image produced.

☒	**A**	Real	Upright
☒	**B**	Real	Inverted
☒	**C**	Virtual	Upright
☒	**D**	Virtual	Inverted

(Total for Question 1 = 1 mark)

2 When a sound wave passes from water into air it slows down. As the wave crosses the boundary from water to air its

☒ **A** frequency decreases.

☒ **B** frequency increases.

☒ **C** wavelength decreases.

☒ **D** wavelength increases.

(Total for Question 2 = 1 mark)

3 Standard candles are used by astronomers to determine the distances to distant star clusters.

A standard candle has a

☒ **A** constant brightness.

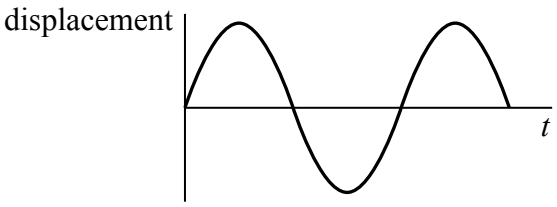
☒ **B** constant luminosity.

☒ **C** known brightness.

☒ **D** known luminosity.

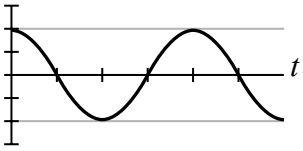
(Total for Question 3 = 1 mark)

4 The graph shows the variation of displacement with time for a particle undergoing simple harmonic motion.

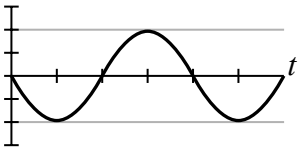


Select the graph that correctly shows the variation of velocity with time for the particle.

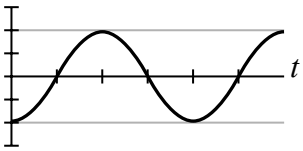
☒ **A**



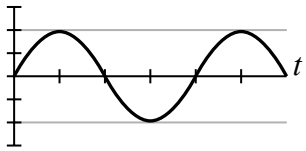
☒ **B**



☒ **C**

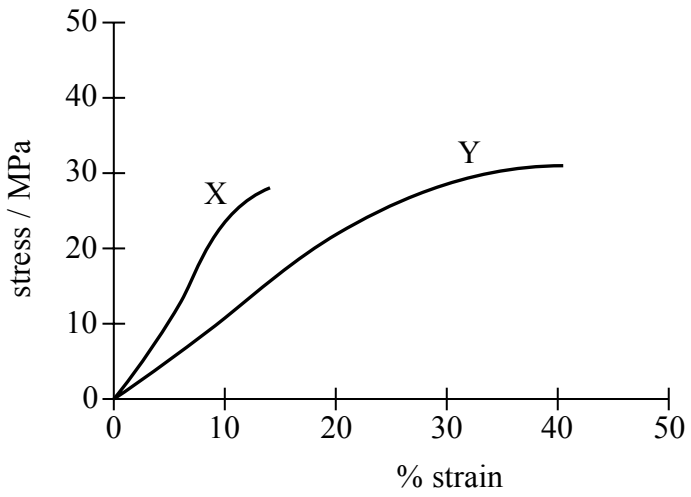


☒ **D**



(Total for Question 4 = 1 mark)

5 The graph shows the behaviour of two materials when placed under stress.



We can conclude from the graph that

☒ **A** material X is stiffer and stronger than material Y.

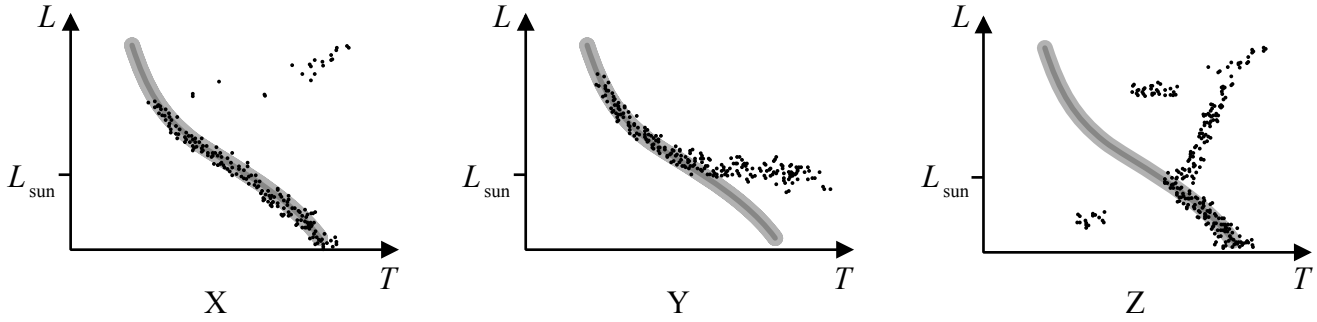
☒ **B** material Y is stiffer and stronger than material X.

☒ **C** material X is stiffer but weaker than material Y.

☒ **D** material Y is stiffer but weaker than material X.

(Total for Question 5 = 1 mark)

6 Hertzsprung-Russell diagrams are shown for three star clusters.



Choose the row that correctly identifies the relative ages of the three clusters.

	Youngest ⟶ Oldest		
☒ **A**	X	Z	Y
☒ **B**	Y	X	Z
☒ **C**	Y	Z	X
☒ **D**	Z	X	Y

(Total for Question 6 = 1 mark)

7 A planet moves around the Sun in a circular orbit of circumference $2\pi r$. The work done in one orbit on the planet by the gravitational force F is

☒ **A** 0

☒ **B** $\pi Fr/2$

☒ **C** πFr

☒ **D** $2\pi Fr$

(Total for Question 7 = 1 mark)

8 A small sphere is falling through a liquid. The viscous drag force acting on the sphere will increase if the

☒ **A** density of the liquid decreases.

☒ **B** radius of the sphere decreases.

☒ **C** temperature of the liquid decreases.

☒ **D** viscosity of the liquid decreases.

(Total for Question 8 = 1 mark)

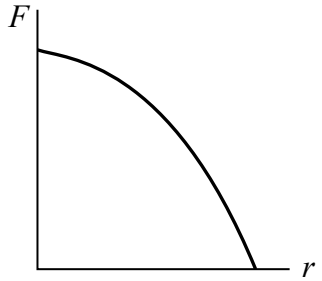
9 A converging lens is used as a magnifying glass. An image is produced that is 30 cm away from the lens and twice as big as the object.

Choose the row that correctly identifies the nature of the image and the object distance.

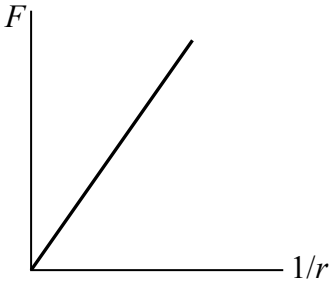
	Nature of image	Object distance/cm
☒ **A**	real	15
☒ **B**	real	60
☒ **C**	virtual	15
☒ **D**	virtual	60

(Total for Question 9 = 1 mark)

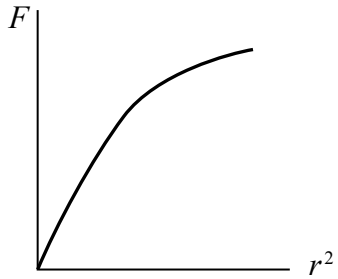
10 Select the graph that shows correctly the relationship between the gravitational force F between two masses and their separation r.



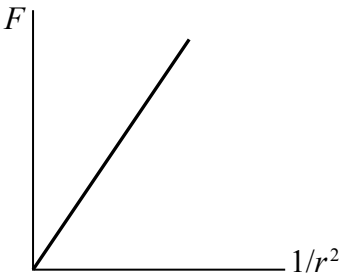
A



B



C



D

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 10 = 1 mark)

11 (a) State what is meant by binding energy.

(2)

(b) In a nuclear fission reaction in power station, a slow-moving neutron is absorbed by a nucleus of U-235
The fission reaction produces nuclei of barium-141 and krypton-92

The equation for the reaction is:

$$^{235}_{92}\text{U} + ^{1}_{0}\text{n} \rightarrow ^{141}_{56}\text{Ba} + ^{92}_{36}\text{Kr} + 3 \times ^{1}_{0}\text{n}$$

Use the data in the table to calculate the energy, in joules, released in this fission reaction.

(3)

	Mass/u
neutron	1.008665
uranium-235	235.0439
barium-141	140.9144
krypton-92	91.9262

Energy = ... J

(Total for Question 11 = 5 marks)

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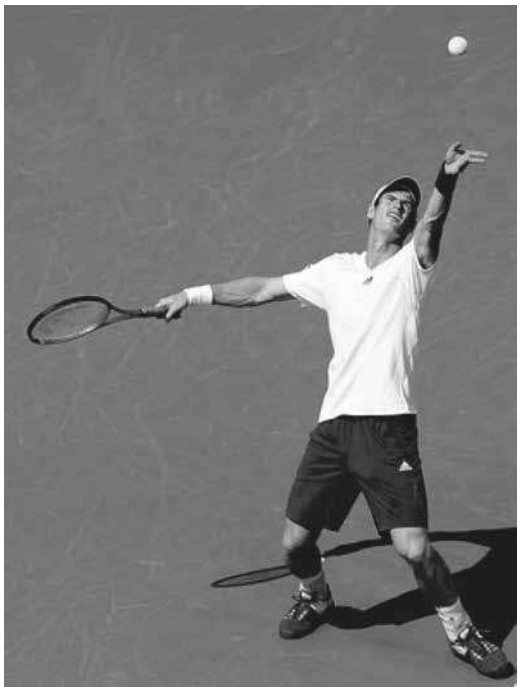
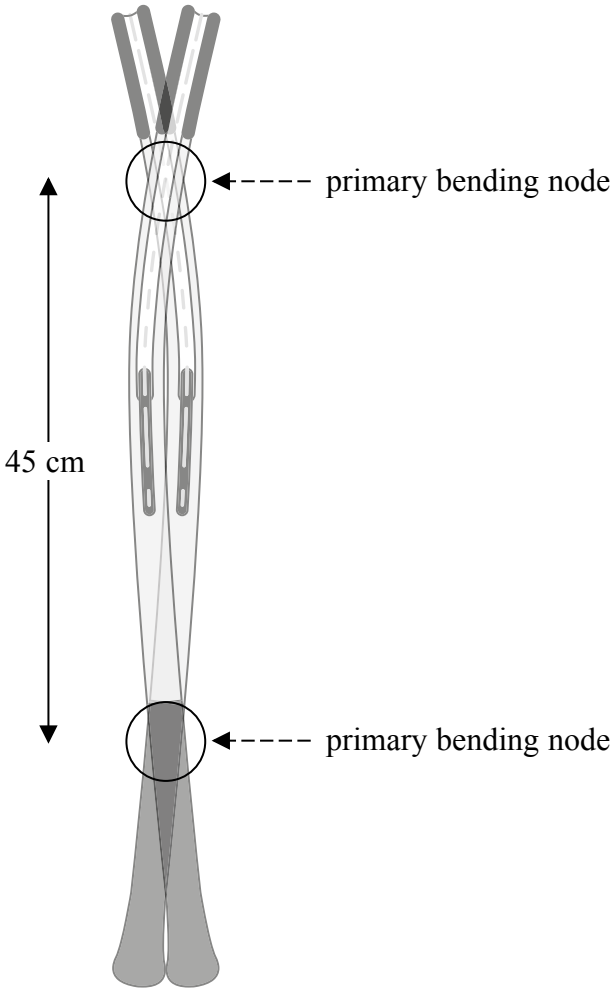
TURN OVER FOR QUESTION 12

12 A tennis player uses a racket to hit a ball over a net. When the racket strikes the ball the racket frame is set into oscillation.

(a) The fundamental mode of oscillation is shown. Transverse waves travel along the length of the racket at a speed of 160 m s^{-1}.



© Getty images

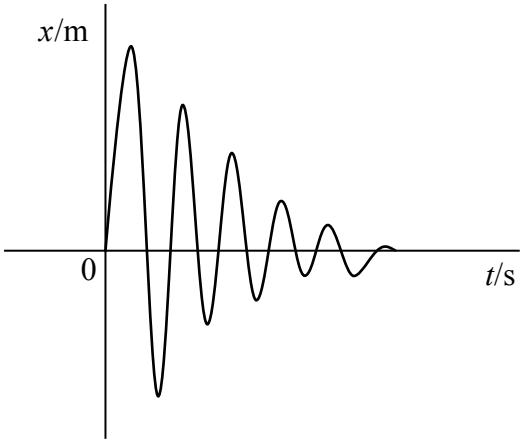


Calculate the frequency of oscillation of the frame.

(3)

Frequency = ...

(b) The graph shows how the displacement x of the centre of the frame varies with time t immediately following the strike.



Hollow spaces are built into the racket frame and small lead spheres are packed into these spaces.

Explain how this results in the graph shown.

(3)

(Total for Question 12 = 6 marks)

***13** The photograph shows a pipe organ in a concert hall.

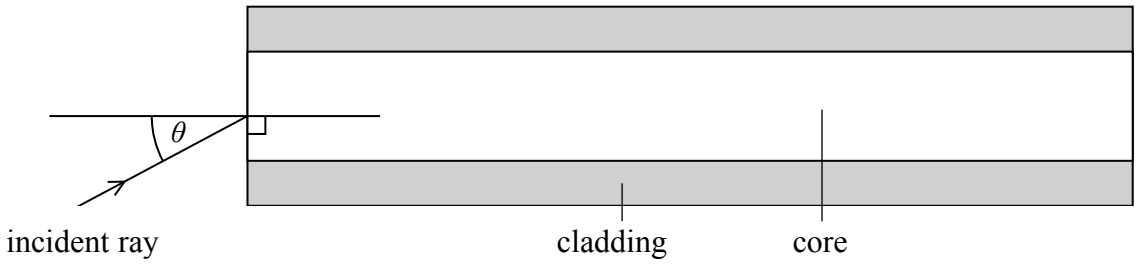
(Source: www.yucatanliving.com/article-photos/news/01042010/pipe-organ.jpg)

When the organ is played, sound travels through the air to a person in the audience as a wave. It is found that there are some positions in the concert hall where particular frequencies are quieter than others.

Explain why this might be the case and give an action that could be taken to eliminate this problem.

(Total for Question 13 = 6 marks)

14 (a) One type of optical fibre is made from a glass core surrounded by a glass cladding of lower refractive index. The light ray passes along the fibre by total internal reflection. The diagram shows a light ray incident on one end of the fibre.



A light ray enters the core with an angle of incidence θ and the angle of refraction is 20°.

Show that the light ray will be totally internally reflected when it meets the boundary between the core and the cladding.

$n_{core} = 1.56$

$n_{cladding} = 1.44$

(4)

(b) Magnifying ‘bug boxes’ are used to observe small insects. One type consists of a clear plastic pot with a snap-on lid.

The lid acts as a converging lens of focal length 8.5 cm.

An insect inside the box appears to be 3.5 times bigger when viewed through the lid.

(i) Draw a ray diagram to show the formation of the image by the lens when used in this way.

(3)

(ii) Calculate the distance of the insect from the lid.

(3)

(Total for Question 14 = 10 marks)

15 An electric drinks cooler is an appliance consisting of a thermally insulated compartment and a heat pump that transfers heat from the inside of the cooler to the room in which the cooler is placed.

This maintains the temperature of the inside of the cooler below the temperature of the room.

(Source: http://www.americanas.com.br/produto/110863245/adega-de-vinhos-easycooler-12 garrafas)

On closing the door of the cooler, warm air at atmospheric pressure and at a temperature of 22.5°C is trapped inside. After a time, the internal temperature stabilises at 3.3°C.

A student notices that the door is difficult to open and concludes that this is because the air inside has cooled down and reduced the pressure.

Carry out a calculation to assess the validity of the student's conclusion.

atmospheric pressure = 102 kPa

area of door = 0.15 m^2

(Total for Question 15 = 7 marks)

16 The picture shows a toy hanging from a spring.

(Source: m4.sourcingmap.com/photo_new/20120821/g/ux_a12082100ux0119_ux_g03.jpg)

The toy has a mass of 0.066 kg. When it is hanging freely on the spring, the spring extends by 4.5 cm.

When the toy is pulled downwards and released, it undergoes simple harmonic motion.

Calculate the frequency of the oscillations.

Frequency = ...

(Total for Question 16 = 5 marks)

17 Tomatoes can be made into a puree.

(a) The puree is heated. When the puree boils, its temperature stays constant, even though the puree continues to be heated.

Explain this observation in terms of molecular energy changes.

(2)

(b) The tomato puree has a mass of 0.444 kg and boils at 101°C. 175 kJ of energy are supplied to bring it to its boiling point from a temperature of 21°C.

Determine the specific heat capacity of the puree.

(2)

Specific heat capacity = ...

(c) The mass of the puree is reduced by boiling. The saucepan is heated by a radiant electric heater run from a mains supply which has a peak voltage of 325 V. The peak current in the heater is 12.4 A.

Calculate the time taken to reduce the mass of the puree at boiling point by 0.225 kg.

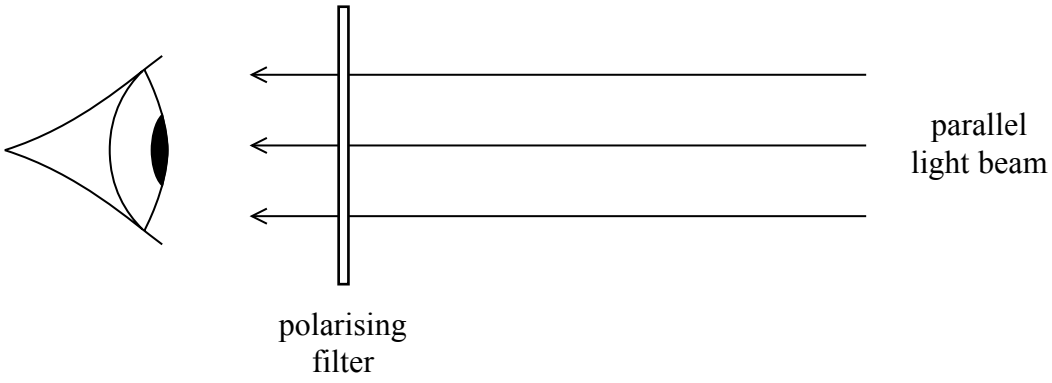
Specific latent heat of vaporisation of tomato puree = 2.37×10^6 J kg^{-1}

(4)

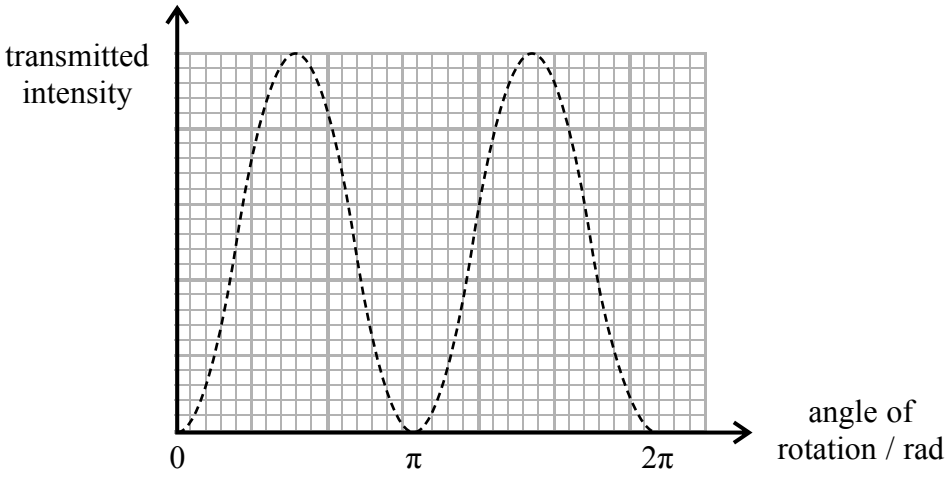
Time = ...

(Total for Question 17 = 8 marks)

18 A student observes a parallel beam of light through a polarising filter.



The polarising filter is rotated through 2π rad in its own plane. The intensity of the light transmitted through the filter varies as shown.



*(a) Explain the observed variation in intensity of the transmitted beam.

(6)

(b) Some sunglasses have lenses made from polarising filters.

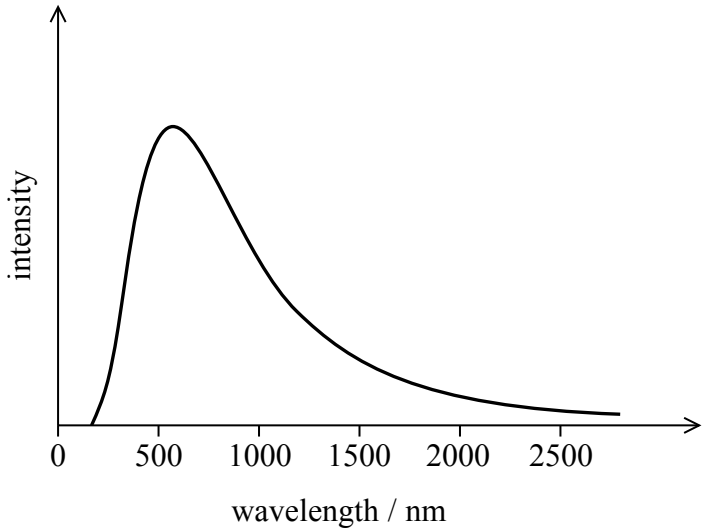
You are given two pairs of identical sunglasses.

Devise a simple test to determine whether the sunglasses use polarising lenses.

(2)

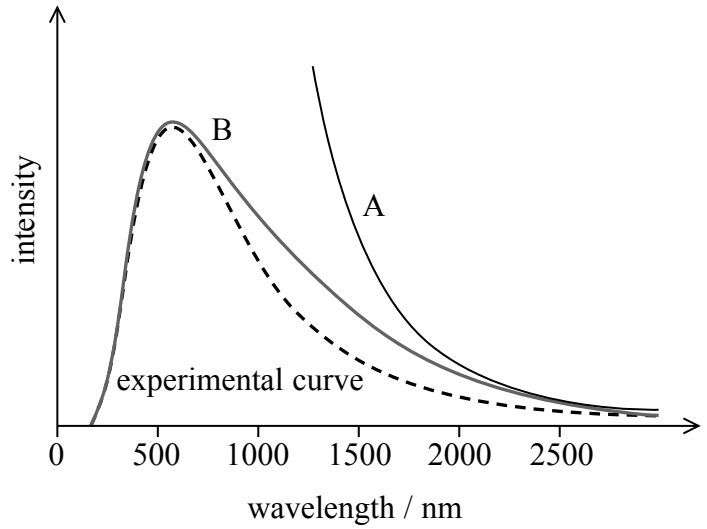
(Total for Question 18 = 8 marks)

19 The diagram shows the radiation curve for a black body radiator. The diagram was obtained from experimental data.



Experimental curve

In the late 19th century, scientists struggled to explain this experimental curve. One model used ideas of classical physics and produced curve A. Another model incorporated the idea of energy quantisation in the mechanism of energy emission and produced curve B. Both curve A and curve B are shown below, with the experimental curve for comparison.



(a) (i) Explain how energy quantisation applies to the emission of radiation of energy from a black body radiator.

(2)

(ii) Assess the extent to which each model is successful at explaining the experimental curve.

(4)

(b) The idea of energy quantisation was used to explain the photoelectric effect, first observed by Heinrich Hertz.
When ultraviolet radiation is shone onto a metal surface, electrons may be released.
A cadmium surface is illuminated with light of wavelength 2.54×10^{-7} m.

Calculate the maximum kinetic energy of the photoelectrons released from the surface.

Work function of cadmium = 4.07 eV

(4)

Maximum kinetic energy = ... J

(Total for Question 19 = 10 marks)

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TURN OVER FOR QUESTION 20

20 About 100 years ago the first measurements of spectra from galaxies beyond the Milky Way were made. Wavelengths of spectral lines were observed to be shifted and Hubble discovered a rough correlation between the shift in the spectral line and the distance to the galaxy.

The graphs below show plots for data collected in 1929 (Figure 1) and 1931 (Figure 2).

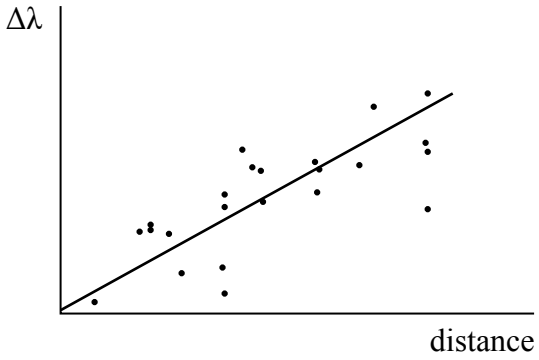

Figure 1

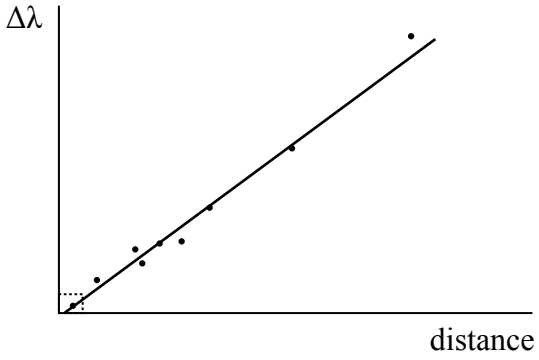

Figure 2

(a) The data used by Hubble for his 1929 plot (Figure 1) is contained within the rectangle close to the origin of the 1931 plot (Figure 2).

Explain how Hubble's observations support the conclusion that the universe is expanding, and assess the reliability of this conclusion on the basis of Hubble's original data.

(5)

(b) The light emitted from a star is due to the energy released by fusion reactions taking place in the core of the star. Our Sun is a main sequence star with a luminosity of 3.85×10^{26} W.
An analysis of the Sun's spectrum gives $\lambda_{max} = 502$ nm

Use the data provided to calculate the radius of the Sun.

(4)

Radius of the Sun = ...

(c) The Sun is believed to be about 4.5 billion years old. To determine this, scientists measure the ratios of the lead isotopes found in meteorites. Since uranium undergoes radioactive decay in a chain to eventually become an isotope of lead, the ratios of lead isotopes can be used to find the age of a meteorite.

(i) $^{238}_{92}U$ decays to $^{206}_{82}Pb$ via the emission of α and β^- radiation.
In the transition of U-238 to Pb-206 eight alpha decays must occur.

State the number of beta decays that must occur. Justify your answer.

(2)

.....

.....

.....

Number of β^- decays = ...

(ii) One isotope produced in the chain is thorium-230, which decays to an isotope of radium with a half-life of 75,000 years.

Calculate the time in years it would take for 90% of an initial sample of thorium to have decayed.

(4)

.....

.....

.....

.....

.....

.....

.....

Time taken = ... years

(Total for Question 20 = 15 marks)

TOTAL FOR PAPER = 90 MARKS