PEARSON EDEXCEL IGCSE PHYSICS · 4PH1

PHYSICS



EXAM QUESTION PACK

SECTION 8: ASTROPHYSICS (PACK 2)

SCORE	PERCENTAGE
/122	%

STEMUP

These questions belong to Pearson Edexcel, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by Pearson Edexcel. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with Pearson Edexcel and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. Pearson Edexcel has not endorsed, approved or been involved in the production of it. Pearson Edexcel and the qualification titles used here belong to their respective owners and appear for identification only.

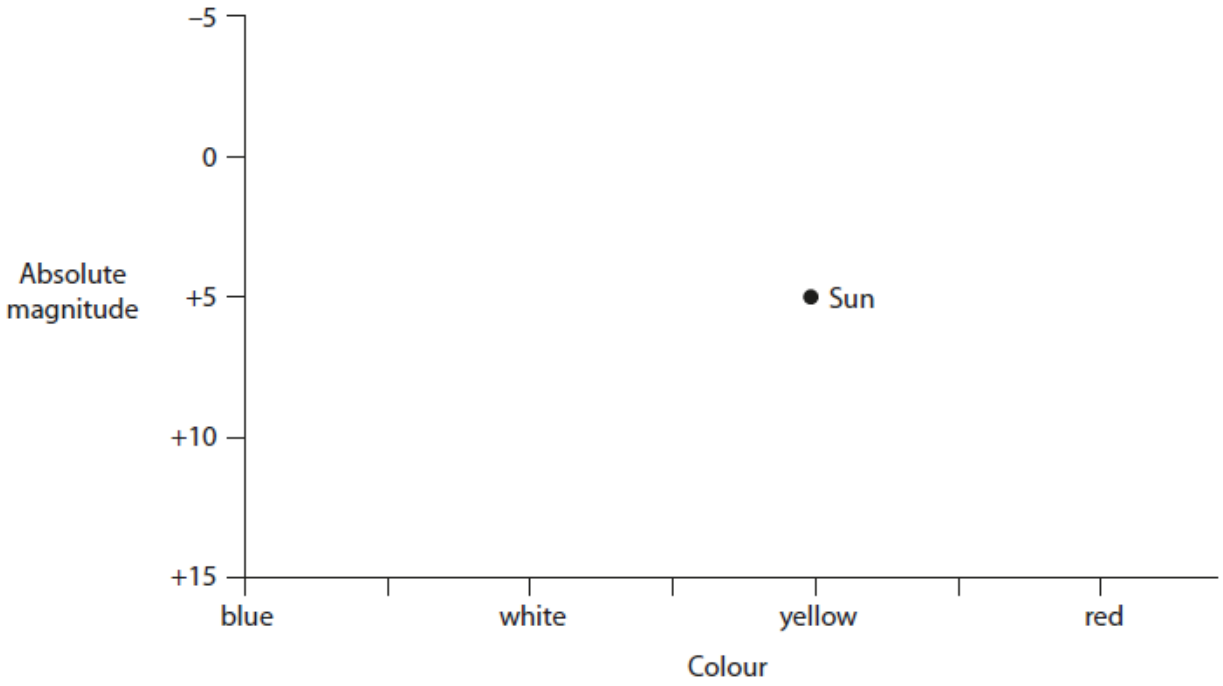
Where to find the originals

Pearson Edexcel publishes its past papers, mark schemes and examiner reports. Always check the current specification at qualifications.pearson.com before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

The Hertzsprung-Russell diagram shows the relationship between the absolute magnitude and colour of stars.



The position of the Sun is shown on the Hertzsprung-Russell diagram.

(a) Star W is a white dwarf.

Add a W to the Hertzsprung-Russell diagram to show the position of star W.

(1)

(b) Star X is a red giant.

Add an X to the Hertzsprung-Russell diagram to show the position of star X.

(1)

(c) Star Y is a main sequence star that is much larger than the Sun.

Add a Y to the Hertzsprung-Russell diagram to show the position of star Y.

(1)

(d) Star Z has the same surface temperature as the Sun, but would be dimmer than the Sun if it were the same distance
away from Earth as the Sun.

Add a Z to the Hertzsprung-Russell diagram to show the position of star Z.

(1)

(e) The Moon is the brightest object in the night sky.

Suggest why the Moon cannot be shown on the Hertzsprung-Russell diagram.

(1)

.....

.....

.....

(Total for question = 5 marks)

Q2.

This question is about stars.

(a) Astronomers measure the absolute magnitude of stars.

State what is meant by the term **absolute magnitude**.

(2)

.....

.....

.....

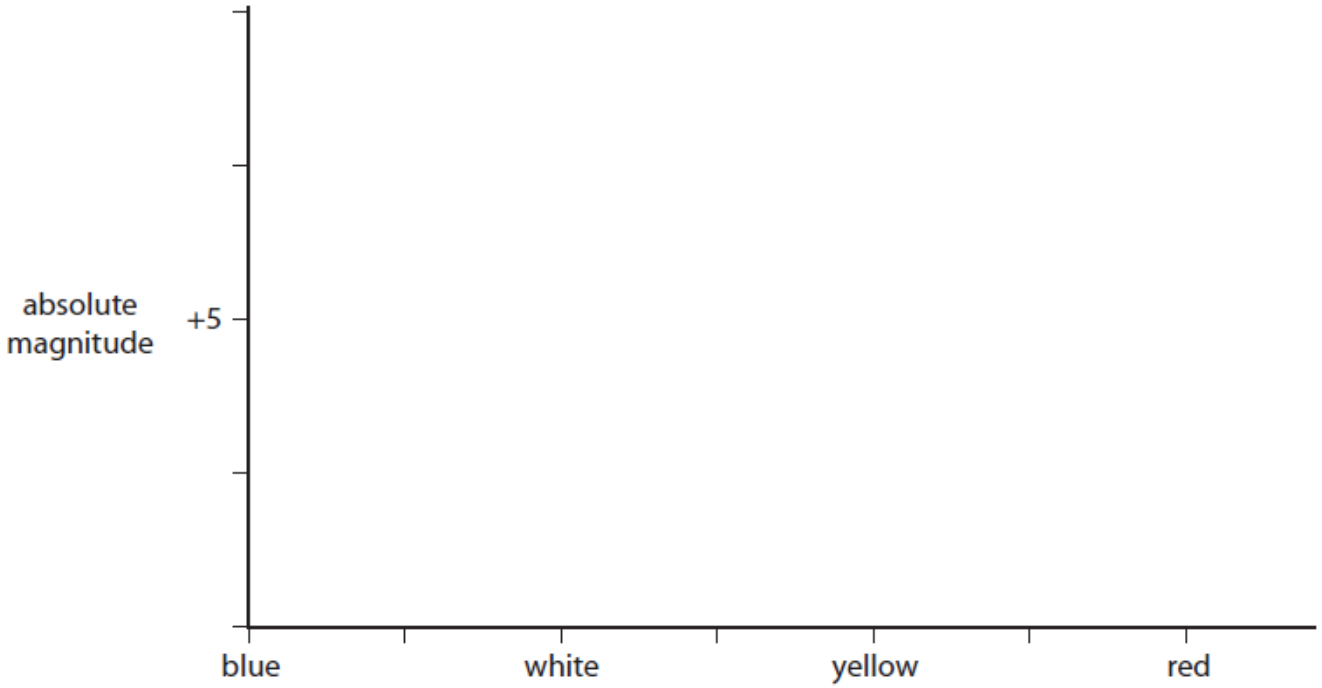
.....

(b) The evolution of stars can be shown on a Hertzsprung-Russell diagram (HR diagram).

Complete the HR diagram by

- labelling the x-axis
- completing the absolute magnitude scale
- drawing the main sequence, red giant and white dwarf regions

(5)



.....

(Total for question = 7 marks)

Q3.

This question is about astrophysics.

(a) (i) What is a star formed from?

(1)

☒ **A** a black dwarf

☒ **B** a nebula

☒ **C** a planet

☒ **D** a white dwarf

(ii) Which of these indicates that the Universe is expanding?

(1)

☒ **A** galaxies are moving further away from each other

☒ **B** galaxies rotate

☒ **C** it takes millions of light years for light to reach us from some stars

☒ **D** some stars in the Milky Way are accelerating towards our Sun

(iii) Which of these provides evidence for the Big Bang theory?

(1)

☒ **A** cosmic microwave background radiation

☒ **B** nebulae

☒ **C** neutron stars

☒ **D** ultrasound radiation

(iv) Which of these does red-shift provide evidence for?

(1)

☒ **A** galaxies are moving away from each other

☒ **B** nebulae contract to form stars

☒ **C** red giants shrink to red dwarfs

☒ **D** white dwarfs expand into red giants

(b) The spectra of stars and galaxies show lines at specific wavelengths that correspond to the spectra of hydrogen, helium and carbon.

Give reasons why lines corresponding to these elements are found in spectra from typical galaxies.

(2)

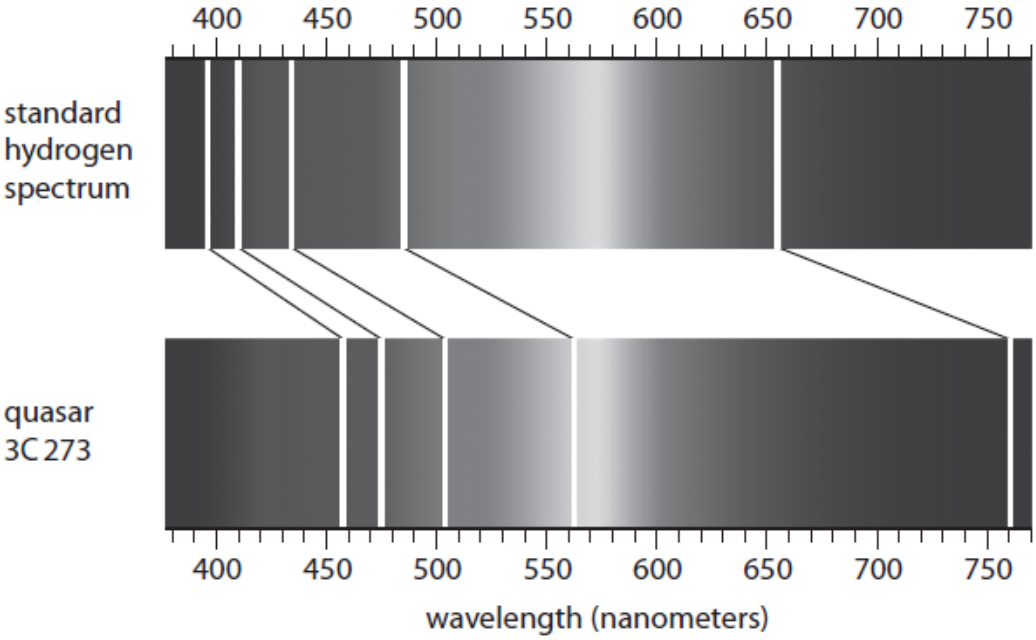
.....

.....

.....

.....

(c) The spectrum of light from an astronomical object called a quasar can be compared to the spectrum of hydrogen on Earth.



(i) Calculate the change in wavelength, $\Delta\lambda$, for the line at the red end of the spectrum.

(2)

$\Delta\lambda$ = ... nm

(ii) Calculate a value for the recessional velocity of the quasar using your value for $\Delta\lambda$.

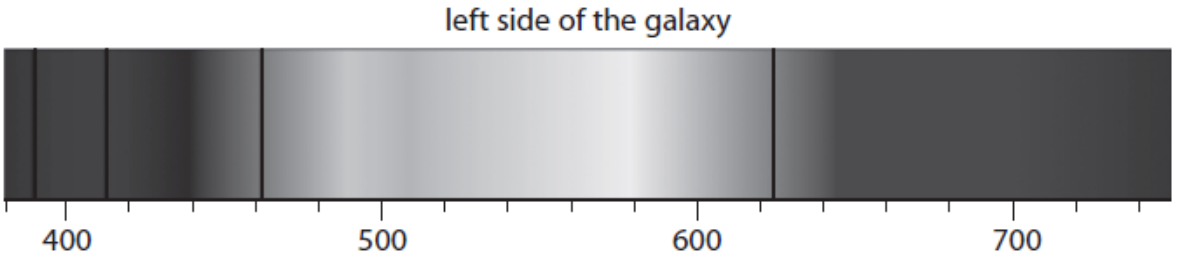
speed of light in free space, $c = 3.0 \times 10^5$ km/s

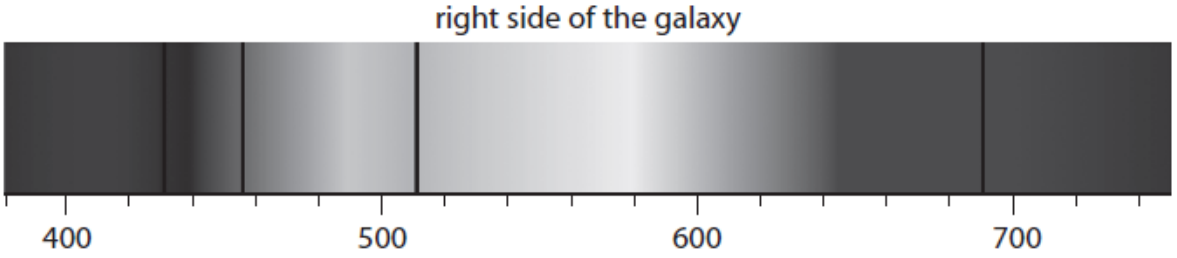
(3)

recessional velocity = ... km/s

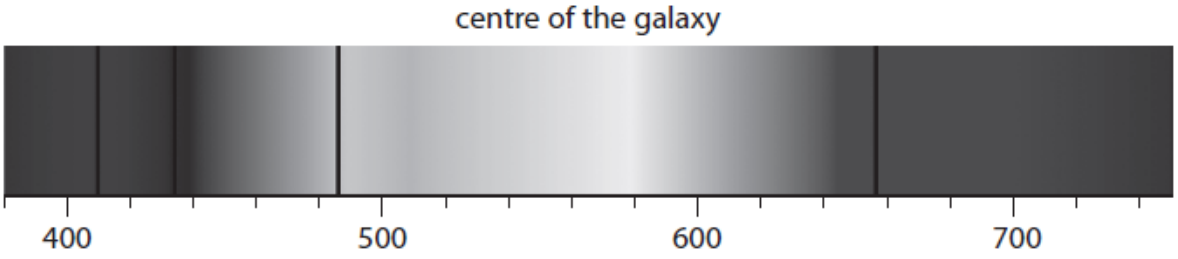
(d) An astronomer observes the light from a nearby galaxy.

She notices that the spectra for hydrogen from the right side and left side of the galaxy are different.





She compares them to the spectrum for hydrogen from the centre of the galaxy.



Explain what information the two spectra give about the movement of the galaxy.

(3)

.....

.....

.....

.....

.....

.....

(Total for question = 14 marks)

Q4.

This question is about astrophysics.

(a) The table lists some statements about the universe.

Place ticks (✓) in the table to show which statements support the Big Bang theory.

(2)

Statement	Supports the Big Bang theory
black holes are formed from extremely massive stars	
cosmic microwave background radiation is detected in all directions	
cosmic rays from space are detected at the Earth's surface	
each galaxy contains billions of stars	
most galaxies show a red-shift in the light detected from them	

(b) The Sun will become a red giant star when it leaves the main sequence.

Which row correctly describes how the surface temperature and brightness of the Sun will change when it becomes a red giant?

(1)

	Surface temperature	Brightness
☒ **A**	decreases	decreases
☒ **B**	decreases	increases
☒ **C**	increases	decreases
☒ **D**	increases	increases

(c) Astronomical objects can be classified by their absolute magnitude.

State what is meant by the term **absolute magnitude**.

(2)

.....

.....

.....

.....

(Total for question = 5 marks)

Q5.

The Big Bang theory describes the evolution of the universe.

(a) Explain how cosmic microwave background radiation (CMBR) supports the Big Bang theory.

(2)

.....

.....

.....

.....

.....

.....

(b) Hydrogen gas in a laboratory on Earth emits light with a wavelength of 605 nm.

A distant galaxy contains hydrogen which emits light of the same wavelength.

The wavelength of the light from the distant galaxy is measured as 683 nm on Earth.

Calculate the speed of the distant galaxy.

[speed of light = 3.0×10^8 m/s]

(4)

speed = ... m/s

(Total for question = 6 marks)

Q6.

The Big Bang theory suggests that the Universe is approximately 14 billion years old.

(a) Describe the evolution of the Universe from the Big Bang until the present day.

(3)

.....

.....

.....

.....

.....

.....

(b) Describe the evidence that supports the Big Bang theory.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 7 marks)

Q7.

(a) State what is meant by the astronomical term **galaxy**.

(1)

.....

.....

(b) Which of these is a large collection of billions of galaxies?

(1)

☒ **A** a nebula

☒ **B** a red giant

☒ **C** the solar system

☒ **D** the universe

(c) Hydrogen is an element that can emit visible light waves.

The table shows the wavelength of one of these waves when detected from a laboratory sample of hydrogen and when detected from the hydrogen in two different galaxies.

The detected wavelengths from the galaxies are different from the detected wavelength from the laboratory sample because of the Doppler effect.

	Wavelength in nm
Laboratory sample	656.45
Galaxy A	656.21
Galaxy B	657.81

(i) Galaxy A and galaxy B are both moving relative to Earth.

Compare the motions of galaxy A and galaxy B relative to Earth.

(3)

.....

.....

.....

.....

.....

.....

(ii) Use data from the table to calculate the speed of galaxy B relative to Earth.

[speed of light, $c = 3.0 \times 10^8$ m/s]

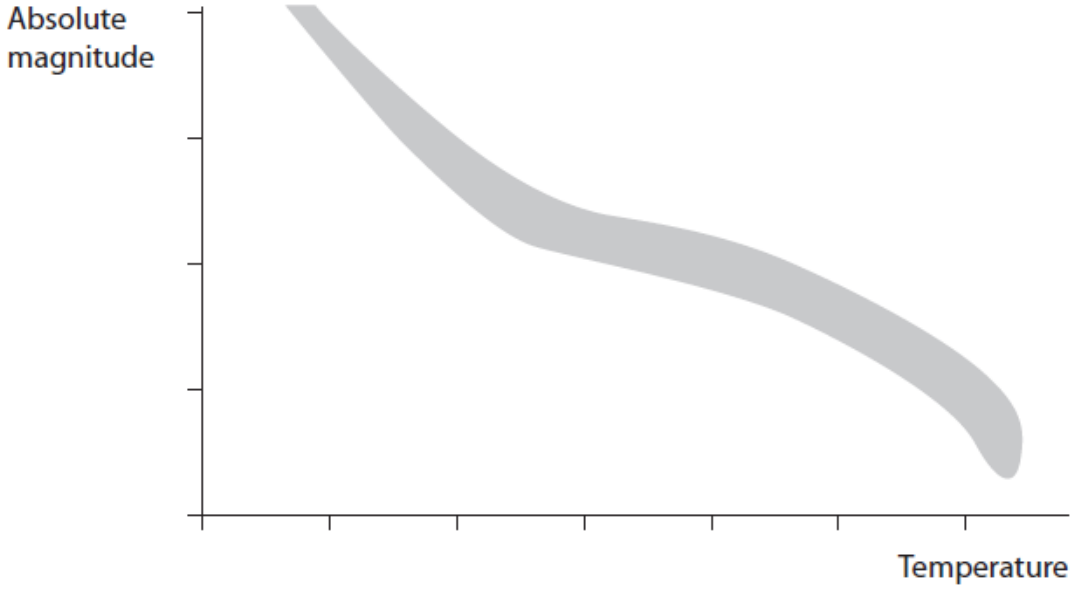
(4)

speed = ... m / s

(Total for question = 9 marks)

Q8.

(a) This is an incomplete Hertzsprung-Russell diagram.



(i) Which of these is in the shaded area of the diagram?

(1)

☒ **A** black holes

☒ **B** main sequence stars

☒ **C** neutron stars

☒ **D** protostars

(ii) On the diagram, draw the area to show the position of white dwarf stars.

Label this area WD.

(1)

(iii) On the diagram, draw the area to show the position of red giant stars.

Label this area RG.

(1)

(iv) State what is meant by the term **absolute magnitude**.

(2)

.....

.....

.....

.....

(b) The Sun emits various parts of the electromagnetic spectrum.

(i) Which part of the electromagnetic spectrum causes damage to human surface skin cells?

(1)

☒ **A** microwaves

☒ **B** radio waves

☒ **C** ultraviolet

☒ **D** visible light

(ii) Which of these increases the risk of damage to human surface skin cells?

(1)

☒ **A** sunbathing

☒ **B** using protective sun cream

☒ **C** very cloudy weather

☒ **D** wearing sunglasses

(Total for question = 7 marks)

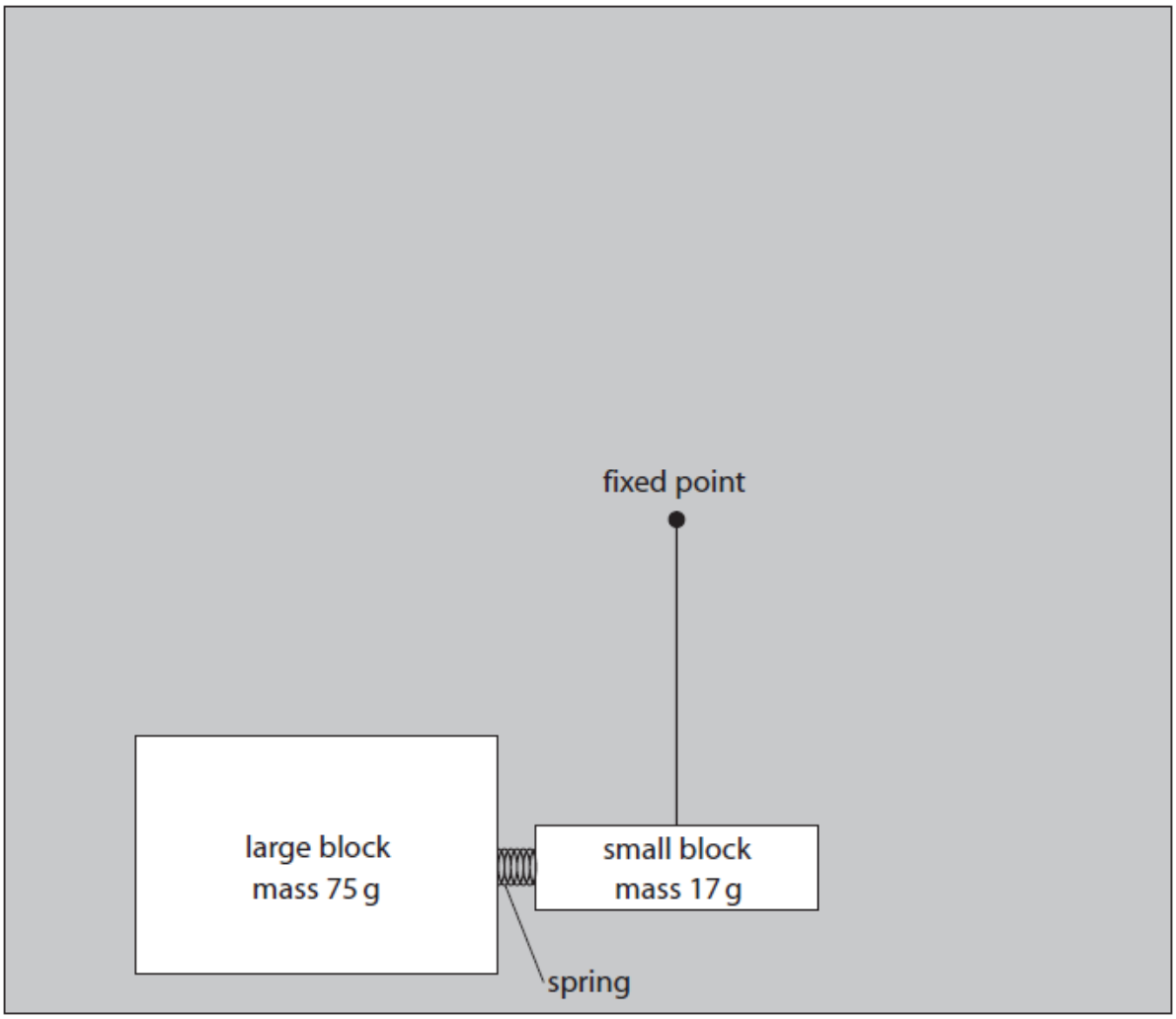
Q9.

The diagram shows two blocks at rest on a table, viewed from above.

A spring is attached to the large block.

The small block is attached by a piece of string to a fixed point on the table.

A student pushes the two blocks together so that the spring is compressed.



(a) The student releases the blocks.

The kinetic energy (KE) store of the small block is 0.29 J when the blocks are no longer in contact.

Show that the speed of the small block is about 6 m/s.

(3)

(b) Using ideas about momentum, show that the speed of the large block is about 1 m/s after the blocks are no longer
in contact.

(4)

(c) The small block takes 0.11 s to reach 6 m/s.

Calculate the mean force exerted on the small block by the spring.

(3)

mean force = ... N

(d) The small block then moves around the fixed point on the table.

The block moves in a circular orbit of radius 17.6 cm at a constant orbital speed of 6 m/s.

The time period of the orbit can be found using the formula

$$\text{orbital speed} = \frac{2\pi \times \text{orbital radius}}{\text{time period}}$$

Calculate the time period of the orbit.

(3)

time period = ... s

(Total for question = 13 marks)

Q10.

The SPS is a particle accelerator in Geneva.

The SPS can accelerate sulfur particles to speeds almost as fast as the speed of light.

(a) Neutral sulfur particles can become positively charged sulfur particles.

Describe the difference between a neutral sulfur particle and a positively charged sulfur particle.

(2)

.....

.....

.....

.....

(b) Diagram 1 shows a section of the SPS.

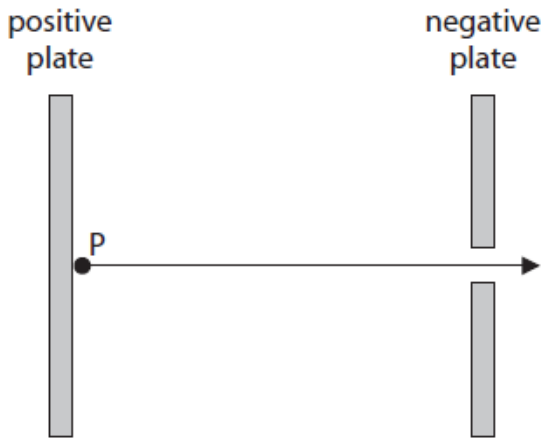


Diagram 1

Positively charged sulfur particles are introduced at point P and accelerate to the right.

Explain why the positively charged sulfur particles accelerate.

(2)

.....

.....

.....

.....

(c) The sulfur particles enter a large tube and complete a circular orbit.

Diagram 2 shows a sulfur particle, travelling with velocity v, in the tube.

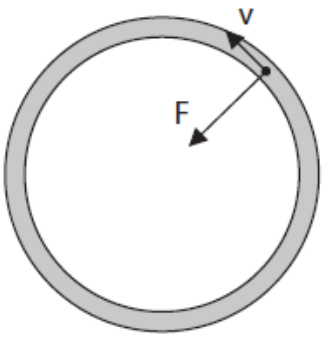


Diagram 2

(i) A magnetic force acts on the positively charged sulfur particle.

This force makes the particle travel in a circle.

The force is labelled F.

Use the left-hand rule to determine the direction of the applied magnetic field.

(1)

☒ **A** ↘ opposite to the direction of the velocity

☒ **B** ↙ along direction of force

☒ **C** ⊙ out of the page

☒ **D** ⊗ into the page

(ii) The tube has a radius of 1.1 km and the sulfur particle has an orbital speed of 2.9×10^8 m/s.

Calculate the orbital period of the sulfur particle.

(3)

orbital period = ... s

(Total for question = 8 marks)

Q11.

The universe began with an event known as the Big Bang.

(a) Describe how the size and temperature of the universe have changed since the Big Bang.

(2)

.....

.....

.....

.....

(b) Discuss two pieces of evidence that support the Big Bang theory.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 8 marks)

Q12.

(a) Give two pieces of evidence for the Big Bang theory.

(2)

.....

.....

.....

.....

(b) Explain how this evidence supports the Big Bang theory.

(4)

.....

.....

.....

.....

.....

.....

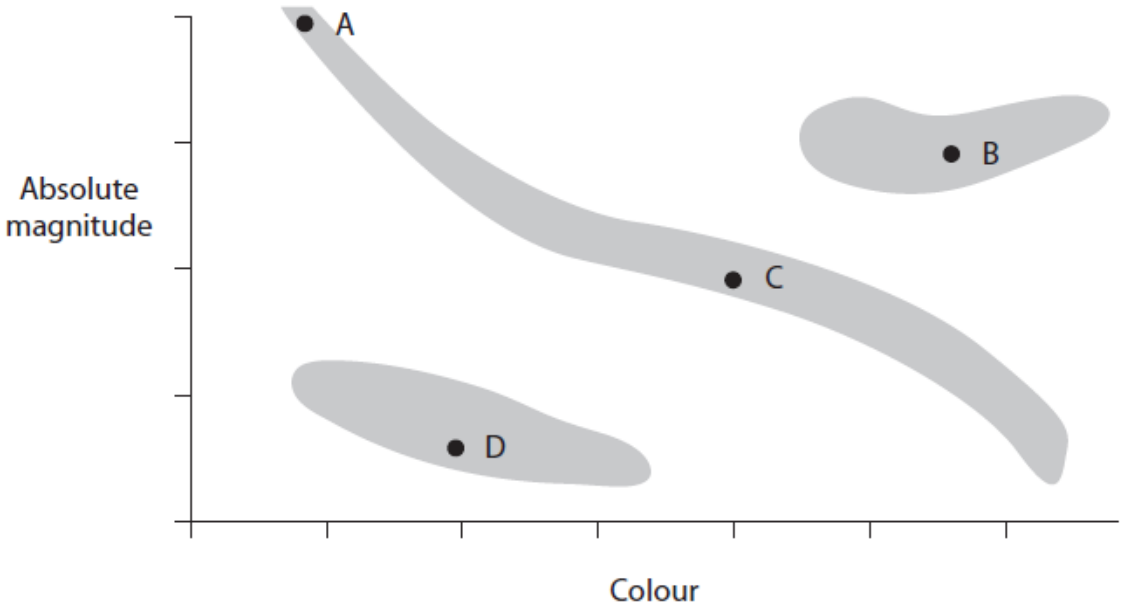
.....

.....

(Total for question = 6 marks)

Q13.

The Hertzsprung-Russell diagram shows stars classified into different regions.



(a) The boxes give four points, A, B, C and D, and four star classifications.

Draw lines connecting each point to the correct star classification.

(4)

Point	Star classification
A	star similar to the Sun
B	white dwarf
C	red giant
D	very bright blue star

(b) Describe what is meant by the term **absolute magnitude**.

(2)

.....

.....

.....

.....

(Total for question = 6 marks)

Q14.

(a) Which force is responsible for keeping satellites in orbit?

(1)

- ☒ **A** electrostatic
- ☒ **B** gravitational
- ☒ **C** magnetic
- ☒ **D** nuclear

(b) Which of these is the largest?

(1)

- ☒ **A** galaxy
- ☒ **B** planet
- ☒ **C** star
- ☒ **D** universe

(c) Which of these represents the brightness of stars at a standard distance?

(1)

- ☒ **A** absolute magnitude
- ☒ **B** colour
- ☒ **C** diameter
- ☒ **D** temperature

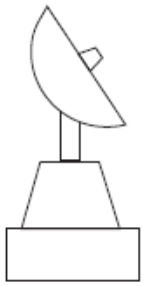
(Total for question = 3 marks)

Q15.

This question is about using radio waves to track an aeroplane.



aeroplane



aerial at airport

(a) Radio waves are emitted from an aerial at an airport, and are then reflected back to the aerial from an aeroplane.

The time taken between emitting the radio waves and receiving the waves back at the aerial is 1.9 milliseconds.

Show that the aeroplane is approximately 300 km away from the aerial.

[speed of radio waves = 3.0×10^5 km/s]

(3)

(b) As the aeroplane travels away from the airport, it sends a signal to the airport using radio waves with a wavelength of 1.2 m.

When the signal is received at the airport, the wavelength is 1.1×10^{-6} m longer than when it is emitted by the aeroplane.

Calculate the speed of the aeroplane using the formula

$$\frac{\text{change of wavelength}}{\text{wavelength}} = \frac{\text{speed of aeroplane}}{\text{speed of radio wave}}$$

[speed of radio waves = 3.0×10^8 m/s]

(3)

speed of aeroplane = ... m/s

(Total for question = 6 marks)

Q16.

(a) (i) A galaxy moves away from the Earth at a speed of 3.9×10^4 km/s.

The speed of light is 3.0×10^5 km/s.

Light from the galaxy is emitted with a wavelength of 6.2×10^{-7} m.

Calculate the change in the wavelength of the light that is received by an observer on the Earth.

(3)

change in wavelength = ... m

(ii) Calculate the wavelength of light that is received by an observer on the Earth.

(1)

wavelength = ... m

(b) One of the pieces of evidence for the Big Bang theory is the red-shift of galaxies.

Explain how the red-shift of galaxies supports the Big Bang theory.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 7 marks)

Q17.

A toy produces continuous waves when floating on the surface of a pool of water.

The waves spread out as circular wavefronts.

Diagram 1 shows the wavefronts produced when the toy is not moving, as viewed from above.

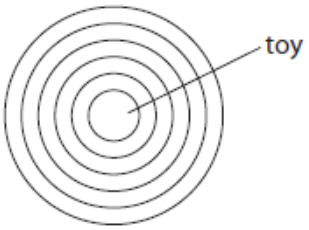


Diagram 1

Diagram 2 shows the wavefronts produced when the toy is moving across the surface of the pool of water.

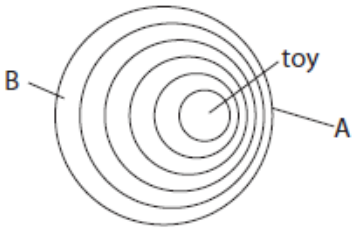


Diagram 2

(a) Draw an arrow on diagram 2 to show the direction the toy is moving.

(1)

(b) Explain how the frequency of the waves at point A is different to the frequency of the waves at point B.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 5 marks)