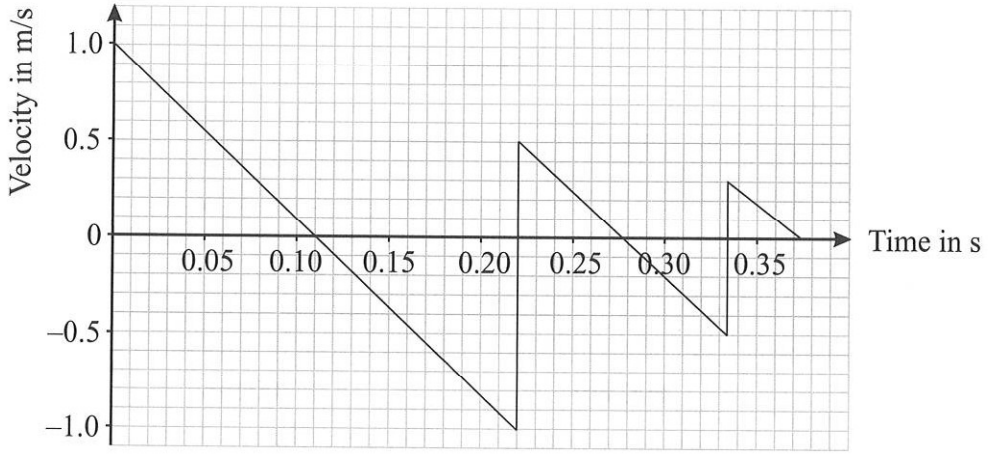
Mixed Questions for Paper 1

1 A boy skims a stone across a lake. **Figure 1** shows the velocity-time graph of how fast the stone is moving in the vertical direction from the time it first touches the water.

Figure 1



a) i) Describe the vertical motion of the stone between 0.11 s and 0.22 s.

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[2]

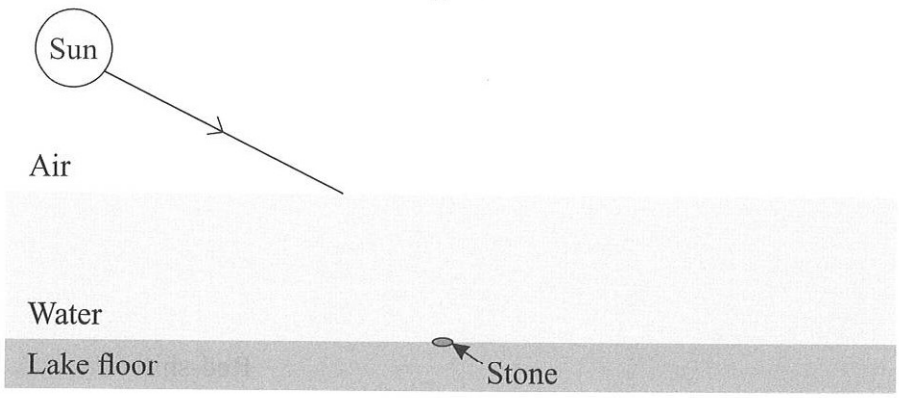
ii) Determine the maximum height the stone reached from the time it first touched the water.

Height = ... m

[2]

b) The stone settles on the lake floor. Light travels through water more slowly than it travels through air. Complete **Figure 2** to show the ray of light from the Sun reflecting from the stone and back out of the water.

Figure 2



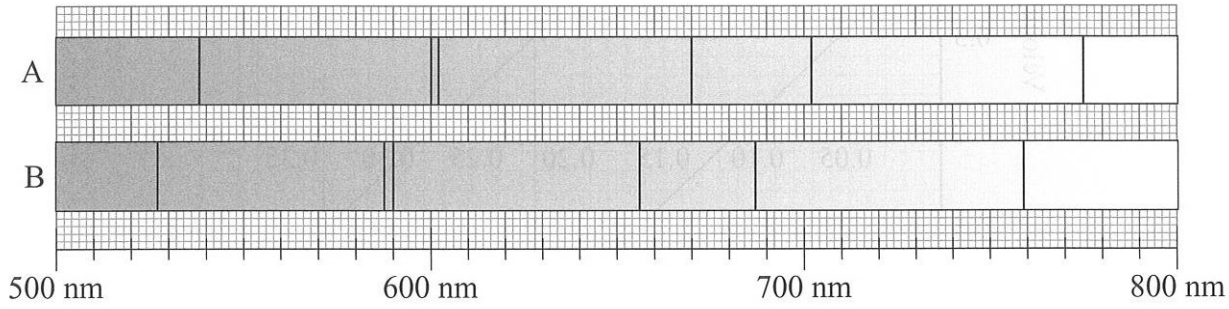
[2]

[Total 6 marks]

2 An astronomer is investigating the visible light from a distant galaxy, galaxy X.
She splits the light observed into a continuous spectrum, known as an absorption spectrum.

In an absorption spectrum, dark lines appear in the spectrum, corresponding to wavelengths of light absorbed by elements in the galaxy. **Figure 3** shows the same parts of two spectra.
Spectrum A is part of the spectrum of the light obtained by the astronomer on Earth.
Spectrum B is part of the spectrum of light that would be obtained if it was detected immediately after it was emitted from galaxy X.

Figure 3



The astronomer observes that the absorption spectra have the same pattern of dark lines, but that this pattern has been shifted by the time it reaches the Earth. This is red-shift.

a) Explain how the behaviour of the universe caused the light from the galaxy to be red-shifted.

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[2]

The red-shift of a galaxy, z, can be calculated using the equation:

$$z = \frac{\Delta\lambda}{\lambda}$$

Where: λ = the wavelength of a dark line in absorption spectrum B
$\Delta\lambda$ = the difference between λ and the wavelength of the equivalent dark line in absorption spectrum A

b) Using **Figure 3**, calculate the red-shift of galaxy X.
Give your answer to two significant figures.

Red-shift = ...

[4]

Galaxy Y is even further away from Earth than galaxy X. The astronomer knows that, at the point of emission, galaxy Y has an identical absorption spectrum to galaxy X.

She compares the visible light absorption spectrum detected on Earth from galaxy Y with spectrum B. She finds that the absorption lines with the longest wavelengths are missing.

c) Explain why the absorption lines are missing from the visible part of the spectrum. Describe what the astronomer could do to observe the missing absorption lines.

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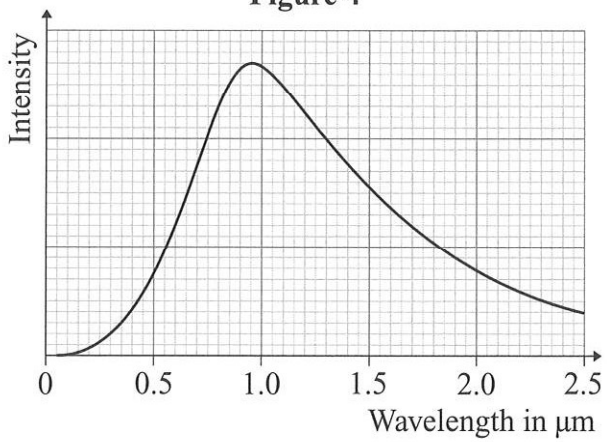
[3]

[Total 9 marks]

3 Star X is a star orbited by two planets, planet Y and planet Z.

The intensity and wavelength distribution of the radiation emitted by star X is shown in **Figure 4**.

Figure 4



a) i) Describe how the curve shown in **Figure 4** would be different, if at all, if it represented the intensity and wavelength distribution of a cooler star of the same size.

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[2]

Star X's gravitational field strength, g, in N/kg, varies with the distance from star X.
It can be calculated using the equation:

$$g = \frac{GM_X}{r^2}$$

where: r = the distance from the centre of star X in m
M_X = the mass of star X in kg = 2.78×10^{30} kg
G = gravitational constant = 6.67×10^{-11} N m^2/kg^2
The distance of planet Y from the centre of star X is 3.29×10^{11} m.

b) i) The weight of planet Y due to the star X's gravitational field is 1.24×10^{21} N.
Calculate the mass of planet Y. Give your answer to three significant figures.

Mass = ... kg
[6]

ii) Planet Y and Planet Z have approximately the same mass.
Planet Z is in a stable orbit at a distance of 2.54×10^{11} m from the centre of star X.
Explain which of planet Y and planet Z has the higher orbital speed.

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[3]

[Total 11 marks]

4 A miner is working in a tunnel. The only light in the tunnel comes from a red light.
The red light is a white bulb which is covered by a red transparent filter.
The miner wears a helmet which appears blue in sunlight.

a) Explain why the bulb appears to be red and what effect this has on the appearance of the miner's helmet.

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[2]

b) In the mine, the miner must also wear a device to monitor her exposure to radon.
Radon-222 is a colourless, odourless radioactive gas which can build up underground.
Radon-222 decays to polonium-218 with the emission of an alpha particle.
The polonium-218 daughter nucleus can undergo alpha decay or beta-minus decay.

i) Explain why the risks to the miner's body from radon are greater than those from a solid source of alpha radiation.

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[3]

ii) Explain how monitoring the miner's exposure to radon can help to ensure her safety.

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[1]

iii) Astatine-218 is produced by the beta-minus decay of polonium-218.
The atomic number of radon is 86. Deduce the atomic number of astatine.

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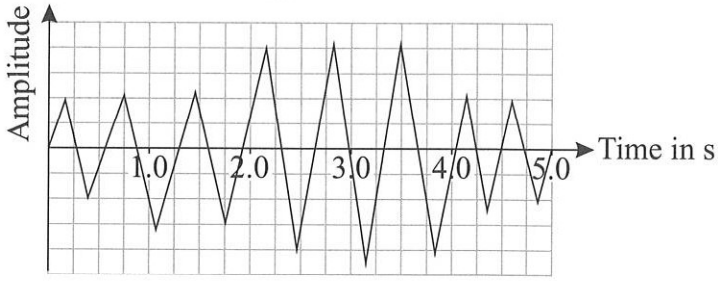
[1]

Once she is a safe distance away, the miner sets off explosives in the tunnel. Seismic waves created by the explosives are recorded at a nearby earthquake-monitoring station.
The station uses equipment to measure the amplitude of the waves over time.
The results are shown in **Figure 5**.

Figure 5



c) The seismic waves travel through the Earth at an average speed of 6400 m/s.
Calculate the average wavelength of the seismic waves.

Average wavelength = ... m

[4]

[Total 11 marks]

Exam Practice Tip

Think carefully about the questions in this mixed topic — they might seem to be asking about one topic, but actually need information from another. You might need to draw together your knowledge from different areas of the course, so bear that in mind if you get stuck.

Score: ☐ / **37**