

Uganda Certificate of Education
PHYSICS 535/1
RESOURCEFUL MOCK PAPER
S.4 Responses, 2025

ITEM 1

a) Scattering of light by the atmosphere causes the sky to appear coloured when the sun is rising. What is observed depends on the colour of light reaching the observer. At the horizon, the sun is furthest from the observer.

The colours of white light are dispersed/refracted at different angles since their refractive index, wavelengths, and speeds are different. The colours with longer wavelengths are refracted/dispersed less, which can be seen from:

For yellow:

$$V = f\lambda \quad \Rightarrow \quad \lambda = \frac{V}{f} = \frac{3 \times 10^8}{5.71 \times 10^{14}} = 5.65 \times 10^{-7} \text{ m}$$

For orange:

$$\lambda = \frac{V}{f} = \frac{3 \times 10^8}{4.80 \times 10^{14}} = 6.25 \times 10^{-7} \text{ m}$$

For red:

$$\lambda = \frac{V}{f} = \frac{3 \times 10^8}{4.06 \times 10^{14}} = 7.39 \times 10^{-7} \text{ m}$$

Therefore, red with the longest wavelength will be more visible (less dispersed), followed by orange and then yellow.

b) The sky is blue during daytime because the blue light, which has a shorter wavelength than other visible light colours, is scattered more in all directions by atmospheric particles; the scattered blue light is distributed uniformly across the sky, giving it the blue appearance.

ITEM 2

a) The objects seen are stars. Stars are formed from a nebula (a dense cloud of dust and gas) that collapsed due to their own gravity and forms high pressure and temp. When two hydrogen atoms combine, they produce a helium atom and energy, the high pressure leads to nuclear fusion hence forming a star.

Distance from the earth, size of the star and amount of energy produced by each star (surface temperature) determine the brightness of a star. Hotter stars are blue while cooler stars are red, the hotter star therefore is bright. The more distant the star, the dimmer it appears. Bigger stars are usually hotter because the rate of nuclear fusion is high, therefore it is also bright.

b) The modern technology is more accurate because it is not hindered by weather changes which a lot affect stars, making them invisible. It is also user friendly as it can be used at any time unlike stars which can only be used at night.

How the modern technology is used (GPS)

Satellites orbit the earth in a special orbit (middle earth orbit) and they broadcast/transmit signals about their orbital position and time using atomic clocks. When the GPS device is

turned on, it receives signals from the satellite that allows the GPS receivers to decode and compute the precise location of the satellite. GPS receivers uses this information and trilateration to calculate the users exact location.

ITEM 3

The luggage and passengers pass through the x-ray scanners for surveillance to detect illegal items.

When the luggage/passengers passes through the scanners, it directs the x-rays of suitable frequency, so that the picture of the internal contents is cast on a screen for analysis.

The rays used for scanning depends on its penetrating power as determined below:

For ordinary light:

$$V = f\lambda$$
$$f = \frac{V}{\lambda} = \frac{3 \times 10^8}{700 \times 10^{-9}} = 4.29 \times 10^{14} \text{Hz}$$

For soft x-rays:

$$f = \frac{V}{\lambda}$$
$$f = \frac{3 \times 10^8}{3 \times 10^{-9}} = 1 \times 10^{17} \text{Hz}$$

For hard x-rays:

$$f = \frac{V}{\lambda}$$
$$f = \frac{3 \times 10^8}{0.03 \times 10^{-9}} = 1 \times 10^{19} \text{Hz}$$

Therefore, ordinary light is not used for scanning because it's not penetrative due to low frequency.

The passengers are scanned by soft x-rays which are less penetrating due to relatively long wavelength and low frequency; this makes it safe for use in human beings.

The luggage is scanned by hard x-rays which are highly penetrating due to a short wavelength and a high frequency.

Since hard x-rays are absorbed by materials while soft materials all allow x-rays to penetrate them, so the scanning of both luggage and passengers is carried out.

Since the soft x-rays are used on passengers, they are safe for use. The x-rays scanning is also safe because the time of exposure is small.

ITEM 4

a) The climber must have worn flat shoes which makes a large contact area hence less pressure which decreased on the ground resulting into sliding (friction) on the ground making it difficult to climb the mountain.

Also work will be done equivalent to:

$$\text{Workdone by the tourist} = mgh = 70 \times 10 \times 5000 = 3.5 \times 10^6 \text{ J}$$

As the tourist moves up the mountain, he does work against gravity equal to $3.5 \times 10^6 \text{ J}$ thus resulting into losing energy hence getting very tired.

b)

Pressure difference = $h\rho g$ for air

$$\rho_{\text{bottom}} - \rho_{\text{top}} = 5000 \times 1.25 \times 10(0.76 \times 1.36 \times 10^4 \times 10) - \rho_{\text{top}} = 62500$$

$$\rho_{\text{top}} = 103360 - 62500$$

$$\rho_{\text{top}} = 40,860 \text{ Pa}$$

The tourist experiences a reduction in external pressure from 103,360 Pa to 40,860 Pa at the bottom and top respectively, but blood pressure remains the same.

The excess internal pressure makes his blood capillaries to burst hence bleeding.

The cooking will take longer and require a lot of heat energy. As the person moves up the mountain, atmospheric pressure reduces (from 103360 to 40,860 Pa). This implies that water boils at a lower temperature, supplying less heat than needed to cook the food. It will take long for the food to get ready making it difficult for the food to get ready.

ITEM 7

a) For series arrangement

$$R = 2 + 2 + 2R = 6 \Omega$$

$$I = \frac{V}{R} = \frac{12}{6} = 2 \text{ A}$$

$$P = IV = 2 \times 12 = 24 \text{ W}$$

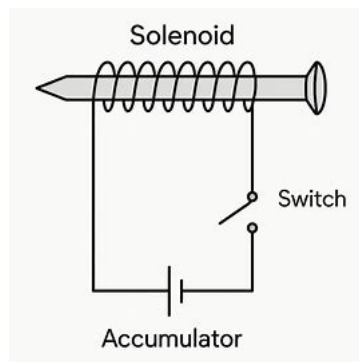
For parallel arrangement

$$\frac{1}{R} = \frac{1}{2} + \frac{1}{2} + \frac{1}{2} = \frac{2}{3} \Omega$$

$$I = 12 \div \frac{2}{3} = 18 \text{ A}$$

$$P = 18 \times 12 = 216 \text{ W}$$

Since power is the rate of doing work, more energy is used/drawn when the power is high. The more energy drawn, the shorter the time it takes to drain the battery. This means series connection would help the student read for long, though with a low current brightness.



b) The students need to make a magnet using electrical method

- Wind the insulated copper wire on a steel nail to form a solenoid and connect it to the ends of an accumulator.
- When the switch is closed, current flows through the solenoid creating a magnetic field around it.
- This magnetised the steel nail in the solenoid.
- Determine the poles of the magnetised nail by looking at the direction of flow of current.
- Remove the magnet from the solenoid and freely suspend it horizontally using a piece of thread.
- The magnet will rest in the north-south direction.
- The students will then move following the south pointing pole of the permanent magnet; making them go back to school.