Neap:

Trial Examination 2009

VCE Physics Unit 2

Written Examination

Suggested Solutions

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SECTION A – CORE

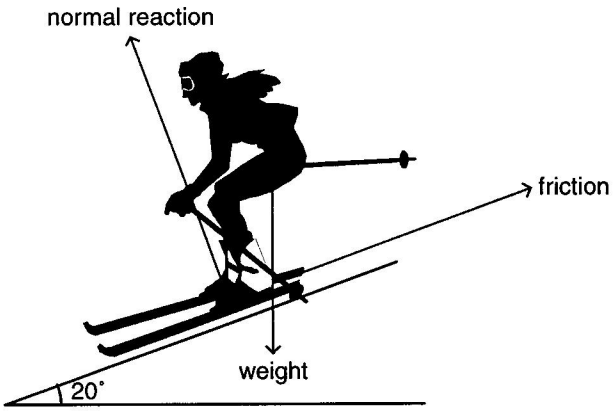
Area of study 1 – Movement

Question 1 **A**

Mass has no direction, only a value, and is therefore not a vector.

1 mark

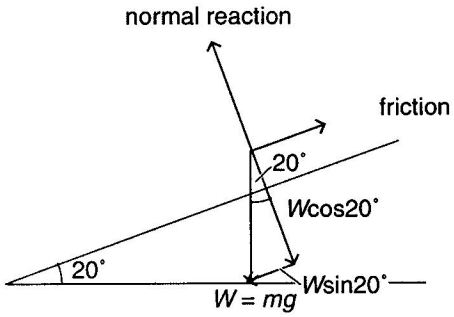
Question 2



3 marks

One mark for each correctly labelled force

Question 3



As seen in the diagram the friction force = sine component of the weight force, since the speed is constant.

So,

friction = $W\sin 20°$ 1 mark

$= 70 \times 10 \times \sin 20°$

$= 239.4$ N

$= 2.4 \times 10^2$ 1 mark

Question 4

Use one of the constant acceleration formulas, in this case $v = u + at$.

So $0 = 15 + 5a$ and $a = \frac{-15}{5.0} = -3.0 \text{ m s}^2$.

(Minus indicates it's in the opposite direction to the motion.) 2 marks

1 mark for the value
1 mark for including the negative sign

Question 5

Use one of the constant acceleration formulas, in this case

$x = ut + \frac{1}{2}at^2$

$x = 15(5) + \frac{1}{2}(-3)(5)^2$ 1 mark

$= 75 - 37.5$

$= 37.5$

$= 38 \text{ m}$ 1 mark

Question 6

Need to calculate the friction on the horizontal section. Use $F = ma$ so $F = 70 \times 3.0 = 210 \text{ N}$. 1 mark

energy = work done 1 mark

$= F \times d$

$= 210 \times 38$ 1 mark

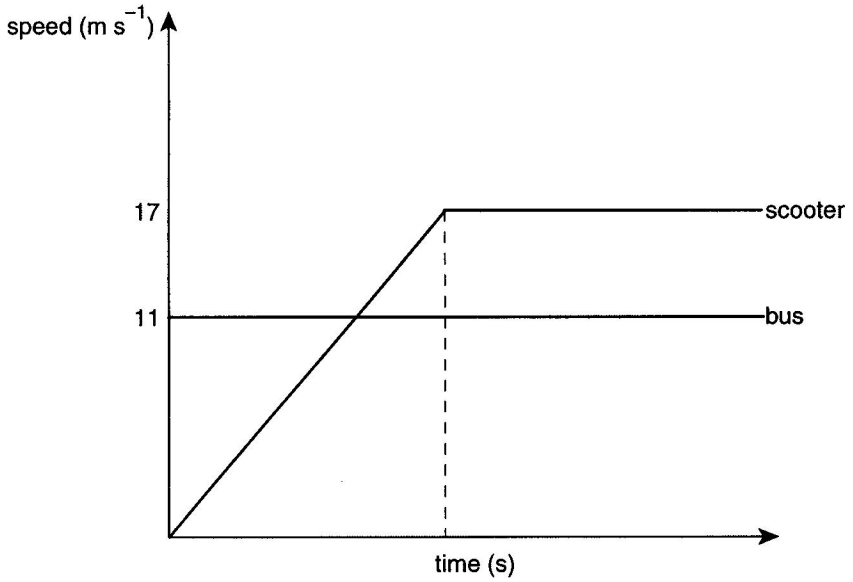
$= 7.9 \text{ kJ}$

Question 7 B

Since the skier is on a slope, the normal reaction is equal to one component of the weight force (perpendicular to the surface) and thus less than the weight force.

1 mark

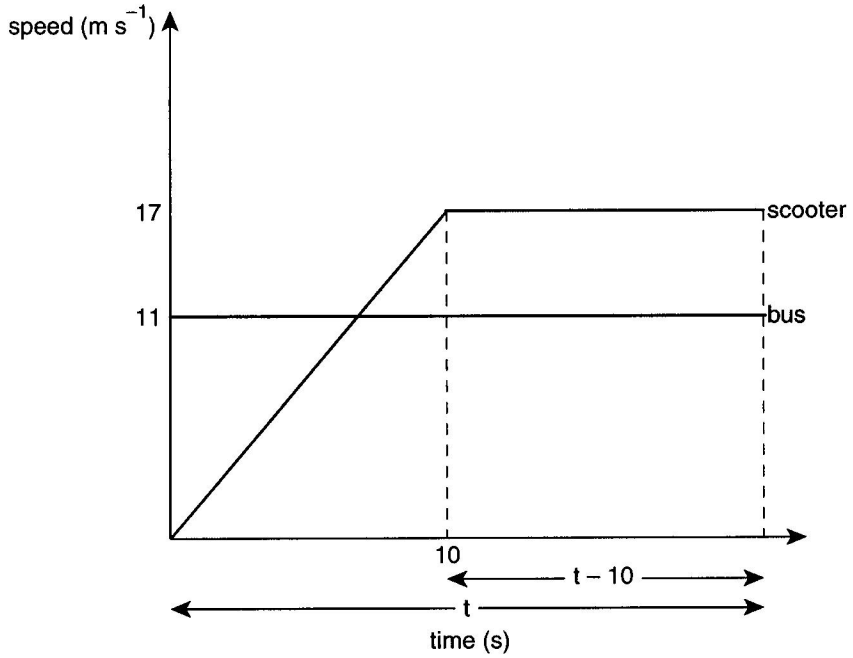
Question 8



3 marks

1 mark for correctly labelling axes
1 mark for correctly labelling bus
1 mark for correctly labelling scooter

Question 9



For the scooter to have caught the bus, both must have travelled the same distance.
Let total time be given by t.

distance bus = distance scooter 1 mark

so,

$$11.1t = \frac{1}{2} \times 10 \times 16.6 + 16.6(t - 10)$$ 1 mark

$$11.1t = 83.3 + 16.6t - 166$$

rearranging and solving for t gives $t = 15$ s. 1 mark

Question 10

Using bus distance:

$d = 11.1 \times 15$

$= 166.6$

$= 1.7 \times 10^2$ m 1 mark

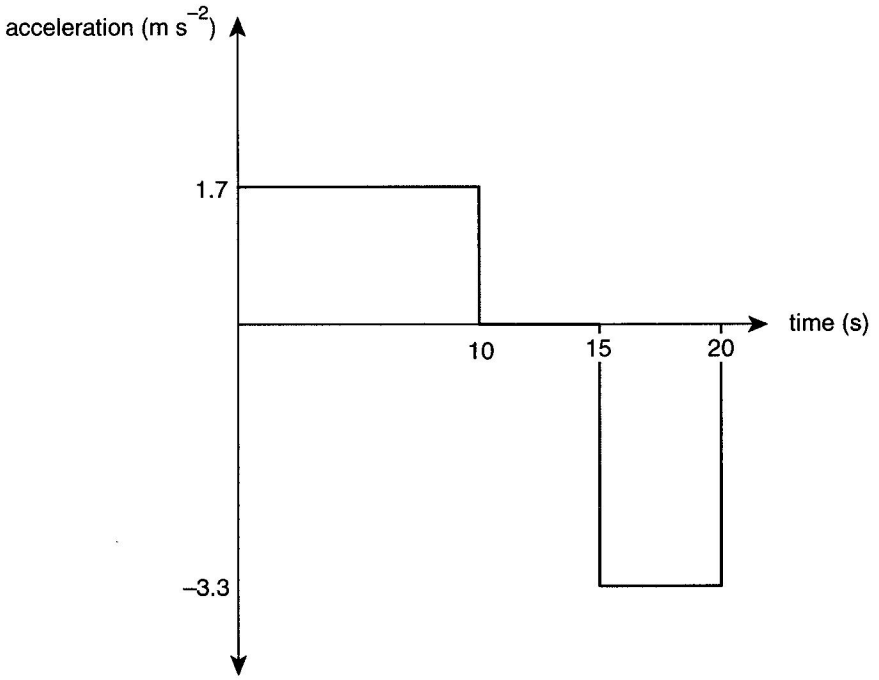
Question 11

The acceleration for the scooter is

$\frac{16.6}{10} = 1.7$ m s^{-2}

It is then 0 m s^{-2} for 5 s, and then

$\frac{16.6}{5} = -3.3$ m s^{-2} (decelerating) 1 mark



1 mark

Question 12 **C**

The acceleration remains constant (10 m s^{-2}), the velocity increases at a constant rate and the displacement increases at a quadratic rate. 2 marks

Question 13

k = gradient of line 1 mark

$= \frac{0.08}{0.004}$

$= 20$ N m^{-1} 1 mark

Question 14

The level of compression needs to be determined to see if it would exceed 1 cm.

The KE of the car $= \frac{1}{2}mv^2$

$= 0.5 \times 0.1 \times 0.18^2$

$= 1.62 \times 10^{-3}$ J 1 mark

The maximum spring energy = Us so,

$\frac{1}{2}kx^2 = \frac{1}{2} \times 20 \times 0.01^2 = 1.0 \times 10^{-3}$ J 1 mark

Since $KE > Us$, i.e. it exceeds the maximum allowable compression so the car will be damaged.
Therefore, the final answer is **No**. 1 mark

Question 15

$GPE = mg\Delta h$

$= 18 \times 10 \times 0.4$ 1 mark

$= 72$ J

Question 16

$KE = GPE$ (assume no loss of energy) so,

$\frac{1}{2}mv^2 = mgh$

1 mark

$\frac{1}{2}mv^2 = 216$

Speed reached by Matilde before collision is given by $v = \sqrt{2g\Delta h} = \sqrt{2 \times 10 \times 0.4} = 2.83$ ms^{-1}. 1 mark

And $p = mv = 18 \times 2.83 = 50.9 = 5.1 \times 10^1$ N s. 1 mark

Question 17

$F = I\Delta t$ so,

$F = \frac{51}{0.5}$

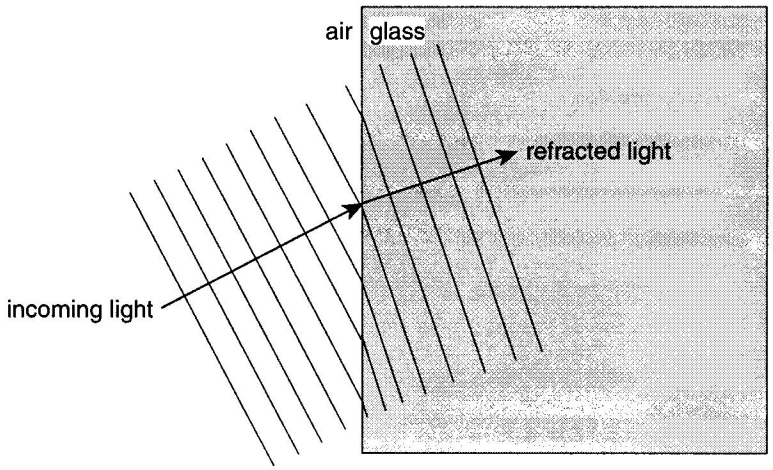
$= 1.7 \times 10^2$ N 1 mark

Area of study 2 – Wave-like Properties of Light

Question 1

For the light to refract towards the normal, the wavelength must be smaller in glass. 1 mark

Therefore its wave speed must be less in glass. 1 mark



1 mark

Question 2

$$n = \frac{v_{air}}{v_{glass}}$$ 1 mark

so,

$$\frac{3 \times 10^8 \text{ m s}^{-1}}{1.4} = v_{glass}$$

$$v_{glass} = 2.1 \times 10^8 \text{ m s}^{-1}$$ 1 mark

Question 3

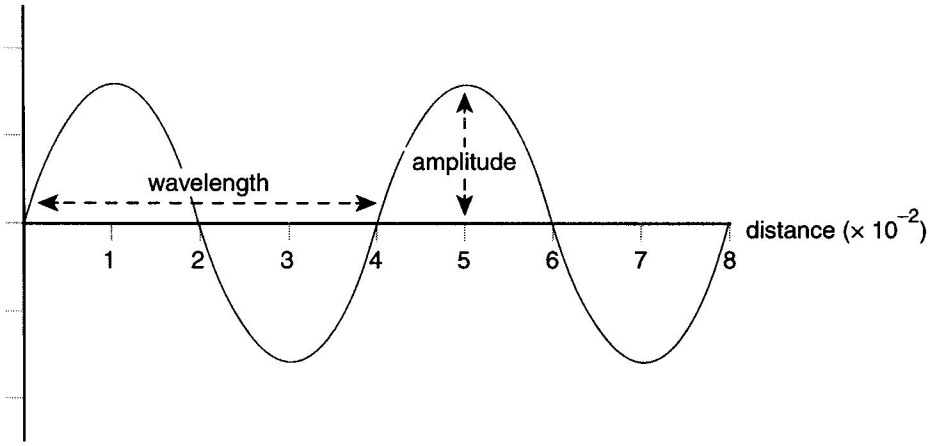
The speed of light in glass is lower than that in air. 1 mark

So Huygens' theory correctly predicts the lower speed of light in glass. 1 mark

Question 4 B

Distance is the most likely quantity because the wave is transversal. 1 mark

Question 5



2 marks

1 mark for correctly labelling amplitude
1 mark for correctly labelling wavelength

Question 6

$v = \frac{\lambda}{T}$ 1 mark

$T = \frac{0.04 \text{ m}}{0.5 \text{ m}}$

$T = 0.08$ s 1 mark

Question 7

No, 1 mark

the wavelength is too small. We cannot see light of wavelengths less than that of violet light. 1 mark

Question 8

The light in question is ultraviolet light. 1 mark

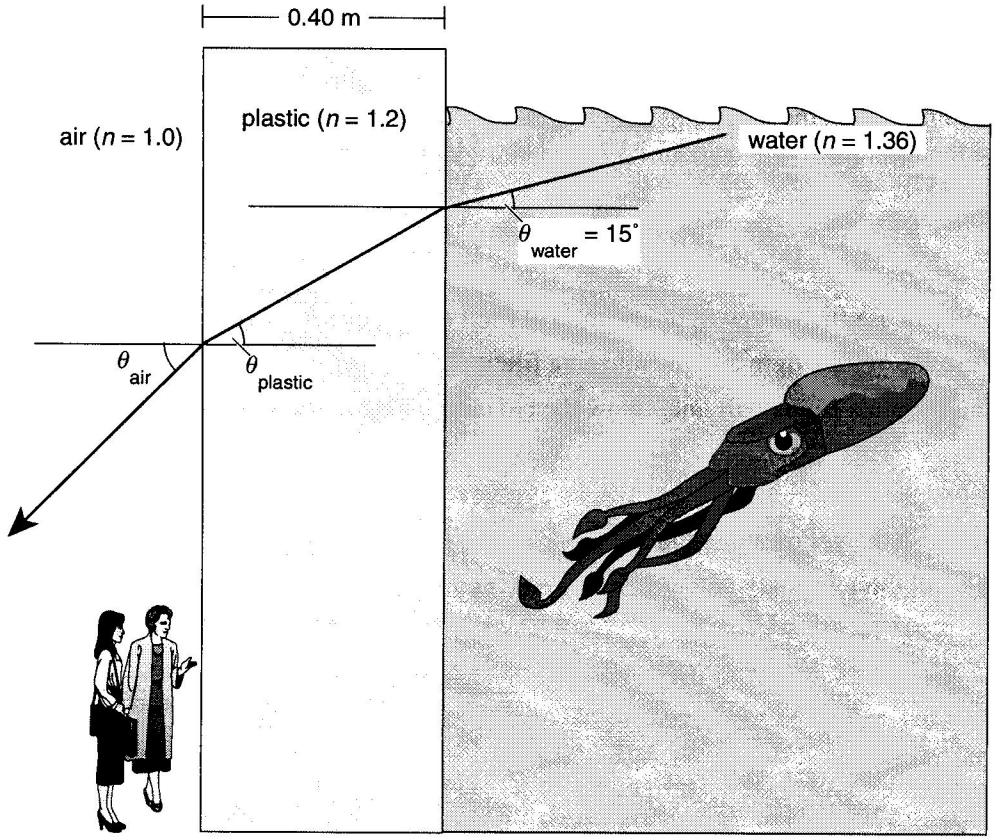
Ultraviolet light is not visible but it is also a form of electromagnetic radiation like visible light, and therefore has many properties in common with visible light. 1 mark

Question 9

The light with the shorter wavelength will have a larger refractive index and will be refracted more. 1 mark

Question 10

The arrow needs to clearly indicate bending away from the normal, so that $\theta_{air} > \theta_{plastic}$.



1 mark

Question 11

$$\sin i \times n_{water} = \sin r \times n_{plastic}$$

$$\frac{\sin 15° \times 1.36}{1.20} = \sin\theta_{plastic}$$ 1 mark

$$\theta_{plastic} = 17°$$ 1 mark

Question 12

$$\frac{n_{air}}{n_{plastic}} = \sin\theta$$ 1 mark

$$0.83 = \sin\theta$$

$$\theta = 56°$$ 1 mark

Question 13

the critical angle 1 mark

Question 14

polarised 1 mark

less 1 mark

45° 1 mark

When light passes through a single polarising filter the emerging light is **polarised**. As a result the emerging light will be **less** bright than the incoming light. If you now put a second filter directly behind the first one in order to reduce the light intensity to about 25% of the original incoming light, the angle between the two filters should be **45°**.

Question 15

Sally and Arnold can use the yellow light and the red filter to produce red light. 1 mark

They can also use the yellow light and the magenta filter. 1 mark

Both the red and magenta filters will only allow the red component of the yellow light to pass through.

Question 16

They will need to use the yellow and blue lights. 1 mark

This will provide all three primary colours (yellow, red and green) and result in white light. 1 mark

SECTION B – Detailed studies

Detailed study 1 – Astronomy

Question 1 **D**

Using the right ascension–declination system is better over a long period of time.

Question 2 **C**

106° – 90° = –16° (– represents south)

Question 3 **A**

In one light-year, light travels 9.5×10^{12} km. So $(9.5 \times 10^{12}) \times 8.6 = 8.1 \times 10^{13}$ km.

Question 4 **D**

Right ascension cannot be negative or greater than 24 h.

Question 5 **B**

Ptolemy thought the motion of celestial bodies was circular and the addition of epicycles enabled the explanation of this irregular motion. He also assumed that the Earth was at the centre of rotation.

Question 6 **B**

Only Venus would change size depending on its phase.

Question 7 **D**

A heliocentric model explained the apparent change in Venus's size.

Question 8 **C**

This telescope uses a convex mirror as the secondary mirror. This is typical of a Cassegrain telescope.

Question 9 **A**

The image is inverted and it does not use a lens. Also, if the mirror is spherical there will be some spherical aberration.

Question 10 **B**

Gamma rays, since they do not reach the Earth's surface.

Question 11 **A**

Better resolution will give greater differentiation between two objects that are close together, thus giving a sharper image.

Question 12 **B**

Nebulae are vast clouds of gas.

Question 13 **A**

An equatorial mount allows easy tracking of a star. Once aligned with the polar axis, it can track the star with adjustments of the right ascension only. An altazimuth mount requires both altitude and azimuth adjustment.

Detailed study 2 – Astrophysics

Question 1 **B**

The black lines in the spectrum are absorption lines that are caused by the absorption of those frequencies by elements in the solar atmosphere.

Question 2 **D**

The Sun's surface temperature is directly related to this maximum energy wavelength.

Question 3 **B**

Henrietta Leavitt's period–luminosity relationship for Cepheid variable stars allowed Hubble to measure distances to nearby galaxies.

Question 4 **C**

For Hubble to measure the distances to some nearby galaxies, one million light years was not enough because the nearest galaxy (Andromeda) is two million light years away. A billion light years was not required. **C** is the best choice.

Question 5 **C**

The best current estimate is 140 billion galaxies in the visible universe.

Question 6 **A**

The H–R diagram traditionally has the surface temperature (in reverse) on the x-axis.

Question 7 **B**

The red giants are more luminous than the white dwarfs. The central band is the Main Sequence.

Question 8 **C**

Since the H–R diagram plots the surface temperature and the luminosity of a star, it is these changing quantities that change the Sun's position on the diagram over time.

Question 9 **B**

For example: ${}_1^1\mathrm{H} + {}_1^1\mathrm{H} \rightarrow {}_1^2\mathrm{H} + {}_1^0e + \nu$

Question 10 **A**

Hubble wanted to find out how the galaxies were moving. He did not expect to find all of them receding from us.

Question 11 **C**

Most galaxies, including all distant ones, are moving away from us. This can be explained by the assumption that the universe is expanding.

Question 12 **B**

This is the only observation that does not support a big bang theory. (Neither does it disprove it!)

Question 13 **B**

It is gravity that forms our universe on the larger scales.

Detailed study 3 – Energy from the nucleus

Question 1 **C**

The nucleus should show both protons and neutrons. All other options will not improve the diagram.

Question 2 **D**

The strong nuclear force acts between both protons and neutrons.

Question 3 **C**

Both statements are correct.

Question 4 **D**

All of the statements are correct interpretations of the equation.

Question 5 **A**

Some of the mass present in the reaction is converted to energy.

Question 6 **D**

Only elements lighter than iron can release energy through fusion.

Question 7 **A**

The graph shows that elements at about half the atomic number of 92 will have more binding energy per nucleon and therefore more binding energy in total, since the number of nucleons is the same for both reactants and products.

Question 8 **D**

Even though fission can occur in many very heavy isotopes, it only occurs readily in uranium-23 and plutonium-239.

Question 9 **D**

Critical mass and critical configuration must be met, as well as the presence of slow (thermal) neutrons.

Question 10 **A**

Fusion is not currently possible in a sustained and confined way.

Question 11 **B**

Heavy water is most likely used as a moderator, not as a coolant.

Question 12 **C**

Both high temperature and high density are requirements for fusion.

Question 13 **A**

The presence of production neutrons, which themselves will cause more fissions, is the key characteristic of a nuclear chain reaction.

Detailed study 4 - Investigations: Flight

Question 1 **B**

At constant speed the thrust = drag = 30 kN.

Question 2 **C**

$$P = Fv = 30\ 000 \times \frac{800}{3.6} = 6.7 \text{ MW}$$

Question 3 **A**

As the hot exhaust gases are expelled (action), the plane moves forward (reaction). This is an example of Newton's third law.

Question 4 **A**

The engine needs to overcome drag only in this situation.

Question 5 **C**

Thrust and lift must overcome drag and weight respectively, since the plane is climbing and accelerating.

Question 6 **A**

Since the helicopter is in equilibrium, the torques must equal each other.

Question 7 **B**

Torque of main rotor = torque of tail rotor, so $F_{TAIL} = \frac{\tau_{MAIN}}{\tau_{TAIL}} = \frac{5 \times 10^5}{4} = 125 \text{ kN}$.

Question 8 **D**

Flapping moves a bird forward, and a bird's wings give it lift.

Question 9 **C**

A wing on a car is inverted compared to the wings on an aeroplane. It needs to provide a downward force.

Question 10 **B**

Since the wing is inverted, the air travelling across the bottom speeds up (its pressure is reduced) to give downward lift.

Question 11 **A**

Pressure drag is due to the shape (form) of the object, while skin friction drag is due to contact between the air and the surface of the object.

Question 12 **C**

By decreasing the angle of attack, fewer vortices are produced and drag decreases.

Question 13 **B**

From the lift equation $L \propto v^2$, so the graph would look parabolic.

Detailed study 5 - Investigations: Sustainable energy sources

Question 1 **D**

Traditionally energy sources have been non-renewable, but we now need renewable energy that can be used at a rate at which it can be replenished (i.e. sustainable).

Question 2 **D**

Solar power is the most promising energy source for Australia, given our land size and sunlight exposure.

Question 3 **B**

Because the 13 W spiral energy-saving globes are 80% more efficient,

$$\text{equivalent incandescent} = \frac{13}{0.2} = 65 \text{ W}.$$

Question 4 **B**

For energy-efficient globe: $E = Pt = 13 \times 3600 \times 1000 = 46.8$ MJ

For an incandescent globe: $E = Pt = 65 \times 3600 \times 1000 = 234$ MJ

So, the difference in energy value = $234 - 46.8 = 187.2$ MJ $= 1.9 \times 10^2$ MJ.

Question 5 **A**

One million tonnes of greenhouse gas is equivalent to 2×10^{10} black balloons so,

2.2 million tonnes $= 4.4 \times 10^{10} = 44$ billion black balloons.

Question 6 **B**

Hydroelectric also produces no greenhouse gases (**A1**), but the fact that the flow of water can be used to control electrical output is its biggest advantage, so **A1** should be used for wind power.

Question 7 **A**

The blades rotate (mechanical) and via the gearbox they rotate the generator. The generator creates electrical energy (electrical), which then drives a pump (mechanical).

Question 8 **D**

$$\text{The kinetic energy} = \frac{1}{2} \times 2000 \times 492 = 49 \text{ kJ} = 49 \text{ kW}$$

$$\text{energy efficiency} = \frac{\text{energy in}}{\text{energy out}} = \frac{20}{49} \times 100 = 41\%.$$

Question 9 **A**

Solar panels need sunlight, so they produce electricity only during daylight hours. A refrigerator needs power at night as well.

Question 10 **C**

$E = Pt = 1050 \times 4.79$ (per day) $\times$ 3600 (per hour) $\times$ 7 (per week) $= 127$ MJ

Question 11 **D**

Electricity is used more for processes other than heating water; hot water is usually limited to showers and/or washing.

Question 12 **C**

Uranium-235 produces $\frac{6.8 \times 10^{13}}{2.5 \times 10^{7}} = 2.72 \times 10^{6}$ times as much energy per kilogram.

So for one tonne this is $\frac{2.75 \times 10^{6}}{1000} = 2.75 \times 10^{3}$.

Question 13 **B**

Uranium power produces little or no greenhouse gas. The other options are all disadvantages of the energy source.

Detailed study 6 - Medical physics

Question 1 **C**

Radioactive sources are used for treatment (e.g. thyroid treatment or cancer treatment) and for therapeutic reasons (i.e. tracers).

Question 2 **C**

α radiation is dangerous because it is highly ionising. Also, it will not be penetrating enough to be detected outside the body.

Question 3 **B**

A CT scan will enable the radiologist to pinpoint the exact 3-dimensional position of the tumour.

A broken bone does not usually require the expense of a CT scan. A simple X-ray photograph will reveal all that the doctor needs to know.

Question 4 **D**

The main reason that ultrasound is used exclusively when imaging unborn babies is because it is non-ionising and non-intrusive.

Question 5 **A**

Ultrasound is reflected more or less depending on the acoustic impedance of the different tissues it encounters. It is the partial reflection that gives the information required to produce an image.

Question 6 **B**

Of the four mentioned here only MRI uses radio frequencies to force resonance of hydrogen atoms.

Question 7 **B**

Only the MRI does not use any ionising radiation.

Question 8 **D**

CT stands for computer (aided) tomography.

Question 9 **C**

A moderately long half-life is required.

If it is too short, there is not enough time to achieve the required outcome. If it is too long, the patient will be subject to unnecessary radiation.

Question 10 **C**

The laser is able to focus the required energy onto a very small area. This way tiny vessels can be sealed without affecting surrounding tissue.

Question 11 **B**

The combinations presented in both **ii.** and **iv.** are correct.

Question 12 **D**

All three stated reasons are valid.

Question 13 **C**

The air inside the ball will have a significantly different impedance to ultrasound than the surrounding tissues. Thus the ball will show up clearly in the ultrasound scan.