Neap:

Trial Examination 2007

VCE Physics Unit 2

Written Examination

Suggested Solutions

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SECTION A – CORE

Area of study 1 – Movement

Question 1

$$t = \frac{s}{v}$$

$$= \frac{60 \text{ m}}{5 \text{ m s}^{-1}}$$

$$= 12 \text{ s}$$ 1 mark

Question 2 **B** 1 mark

As Theo's velocity is constant, the net force acting on him must be zero.

Question 3

$$s = \frac{u + v}{2} \times t$$

$$= \frac{0 + 15}{2} \times 10$$ 1 mark

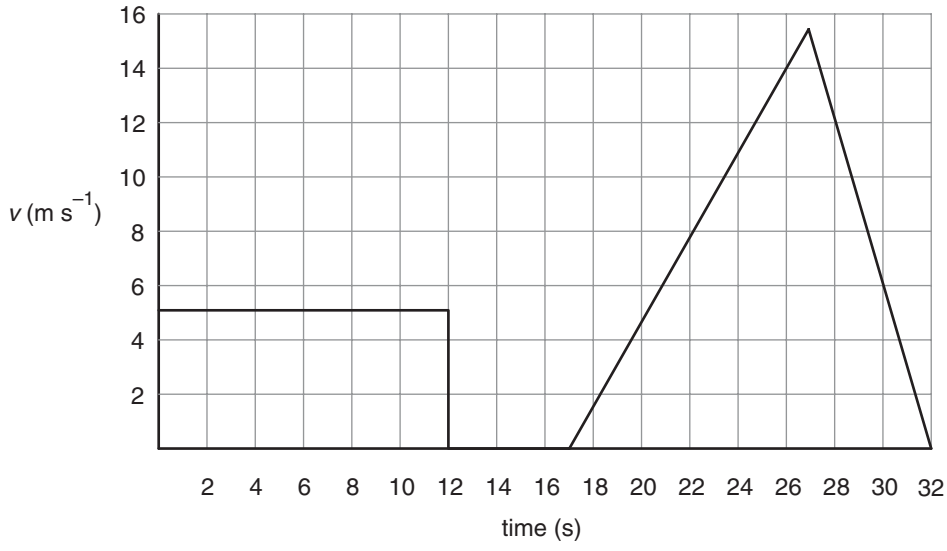
$$= 75 \text{ m}$$ 1 mark

Question 4

First law: Theo comes to a stop because there is a non-zero force acting on him (friction). 1 mark

Second law: Theo comes to a stop because the net force on him causes an acceleration in the direction opposite to that of his velocity. The magnitude of the acceleration depends on the size of the force and on Theo's mass. 1 mark

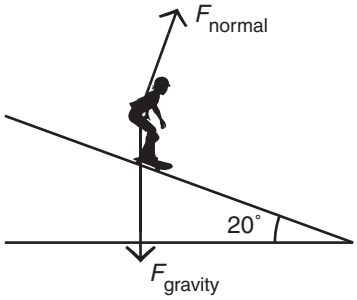
Question 5



3 marks

1 mark for correctly labelled horizontal axis
1 mark for correctly labelled vertical axis
1 mark for correct graph

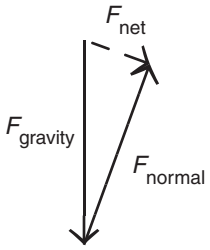
Question 6



2 marks

1 mark for correctly labelled gravitational force
1 mark for correctly labelled normal reaction force

Question 7



1 mark

$\sin 20° = \dfrac{F_{\text{net}}}{F_{\text{gravity}}}$ 1 mark

$F_{\text{net}} = \sin 20° \times F_{\text{gravity}}$

$F_{\text{net}} = 205$ N 1 mark

Question 8

$E_{\text{gravitational}} = E_{\text{kinetic}}$

$mgh = \dfrac{1}{2}mv^2$ 1 mark

$h = \dfrac{0.5v^2}{g}$

$h = 7.2$ m 1 mark

Question 9

Without friction

Flora would not go faster if she were heavier, 1 mark
because her acceleration due to gravity would be the same regardless of her mass. 1 mark

With friction

Flora would not go faster if she were heavier, 1 mark
because on a heavier person, the frictional force would be greater as it is proportional to mass (normal force), but the component of weight parallel to the slide is also proportional to mass.
Hence the net force is independent of mass. 1 mark

Question 10

work = change in E_{kinetic} 1 mark

$\text{work} = \dfrac{1}{2}mv^2$

$= 2520$ J 1 mark

Question 11

change in E_{kinetic} = work

$\frac{1}{2}mv^2 = Fs$ 1 mark

$F = 360$ N 1 mark

Question 12

Explanation 1: Newton 1 mark
This explanation uses Newton's second law of motion.

Explanation 2: Aristotle 1 mark
This explanation uses the idea of a 'natural motion' associated with a particular object.

Explanation 3: Galileo 1 mark
This explanation uses the notion of inertia.

Question 13

spring constant $(k) = \frac{F}{x}$

$k = \frac{40}{0.20}$ 1 mark

$k = 200$ N m^{-1} 1 mark

Question 14

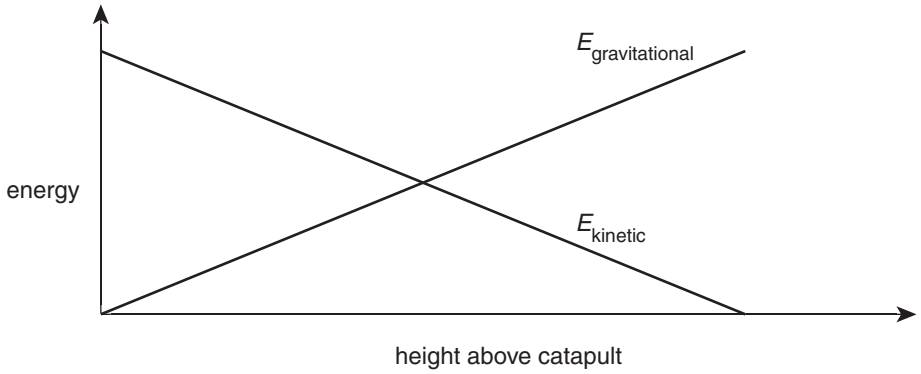
$E_{\text{strain}} = E_{\text{gravitational}}$

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

$h = \frac{0.5kx^2}{mg}$ 1 mark

$h = 20$ m 1 mark

Question 15



2 marks

1 mark for straight lines (as energy must be conserved)
1 mark for correct labelling of kinetic and gravitational energies

Question 16

In the absence of friction, the final speed of the falling stone is equal to its initial speed. 1 mark
This means that it is safer to move away as the stone comes down (or wear a helmet). 1 mark

Area of study 2 – Electricity

Question 1

In science, a model is a familiar concept used in place of a more complex or unknown entity. 1 mark
Using models helps us to explain and understand new ideas. 1 mark

Alternative answer:
A model is a testable representation based on observations about how some part of the world works. 1 mark
It should allow us to develop explanations about aspects of the observations. 1 mark

Question 2

$R_{\text{total}} = R_1 + R_2$

$= 40 + 80$

$= 120\ \Omega$ 1 mark

$V = IR$

$240 = I \times 120$ 1 mark

$I = 2$ A 1 mark

Question 3 B 2 marks

This is a series circuit, and the current is the same at all points in a series circuit.

Question 4

$P = I^2R$

$P = 2^2 \times 80$ 1 mark

$= 320$ W 1 mark

Consequential marks for $(Q2)^2 \times 80$

Question 5 B 2 marks

The current at *X* has increased.

Question 6

Adding a resistor in parallel effectively reduces the total resistance of the circuit. 1 mark
As the potential difference of the circuit is unaltered 1 mark
and the resistance has been reduced, a greater current can exist in the circuit. 1 mark

Alternative answer:
The current through the 120 W resistor is 2 A. 1 mark
The current through *Y* must still be 2 A. Hence the current through *X* must be 4 A. 1 mark
For each loop, Σ emfs = Σ potential drops. 1 mark

Question 7

$P = \frac{V^2}{R}$ and $P = \frac{U}{t}$

$P = \frac{V^2}{R} = \frac{U}{t}$ 1 mark

$\frac{240^2}{120} = \frac{U}{10}$ 1 mark

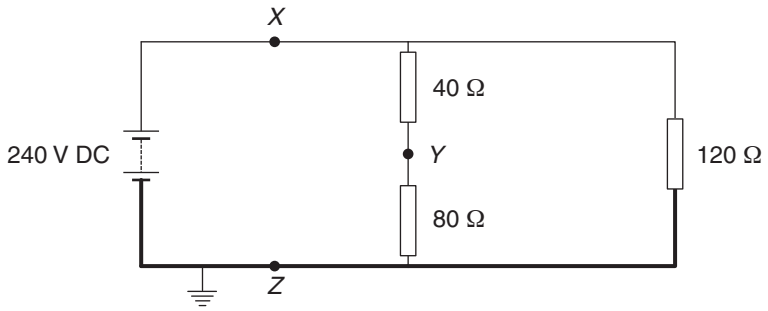
$U = 4800$ J 1 mark

1 kW h = 3.6 MJ, so 1 J = 2.78×10^{-7} kW h

4800 J = $4800 \times 2.78 \times 10^{-7}$

$= 1.33 \times 10^{-3}$ kW h 1 mark

Question 8



1 mark

1 mark for earth placed anywhere along the darker line in the circuit

Question 9

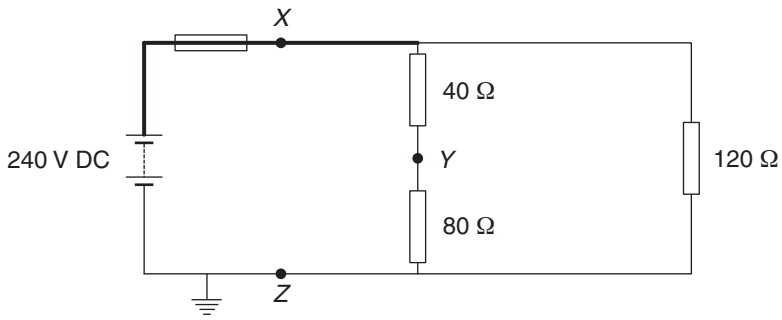
Earthing ensures that part of the circuit remains at 0 V. 1 mark

Question 10

A fuse is designed to melt when the current is too large. 1 mark

This opens the circuit, ensuring that the current becomes zero. 1 mark

Question 11



1 mark

1 mark for fuse placed anywhere along the darker line in the circuit

Question 12

The fuse should be placed where the current is greatest in the circuit. 1 mark

This means that the fuse will melt if too much current is drawn through any device. 1 mark

It is preferable to place the fuse at X rather than at Z since if the fuse at X melts, there is no chance for current to flow in the circuit. If the fuse is at Z and melts and someone touches Y, the person could conduct current to earth which could be harmful to them.

Question 13

Device A 1 mark

The V–I graph for Device A is linear, which means that Device A's resistance is constant.

Question 14

Reading from Figure 4 in the question booklet, when the potential difference across Device A is 6 V, the current is 0.6 A. 1 mark

Question 15

As Device A and Device B are in series, the current is the same is each device.

The current in Device B is then 0.6 A. 1 mark

Reading from Figure 5 in the question booklet, the potential difference across Device B is then 2 V. 1 mark

The voltage supplied by the battery is $V_A + V_B = 6 + 2 = 8$ V 1 mark

SECTION B – Detailed studies

Detailed study 1 – Astrophysics

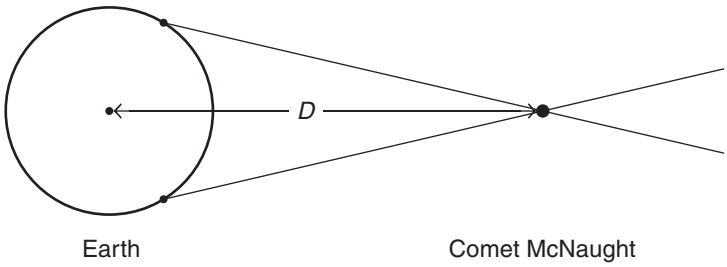
Question 1

gravitational 1 mark

fusion 1 mark

stars 1 mark

Question 2



The parallax method can be used. 1 mark

As seen from two different points on Earth's surface, the comet seems to be at a different position relative to the background stars. This parallax shift is proportional to the distance (D). 1 mark

This allows astronomers to calculate the distance between the comet and the Earth.

Question 3 **C** 1 mark

The Sun is about 150000000 km from Earth.

Question 4

'Luminosity' refers to the actual or objective brightness of a star, or the amount of light energy it emits per second. 1 mark

Question 5

Hubble had to assume that all galaxies are approximately equally bright. 1 mark

Then, by comparing the relative brightness of galaxies of unknown distance with that of galaxies of known distance, 1 mark

he was able to work out the unknown distances with the inverse square law. 1 mark

Question 6

Hubble needed to know the red shift of each galaxy. 1 mark

This allowed him to calculate how fast each galaxy was moving away from ours. 1 mark

Question 7

Horizontal axis: distance to galaxy 1 mark

Vertical axis: recession speed 1 mark

Question 8

Hubble's constant 1 mark

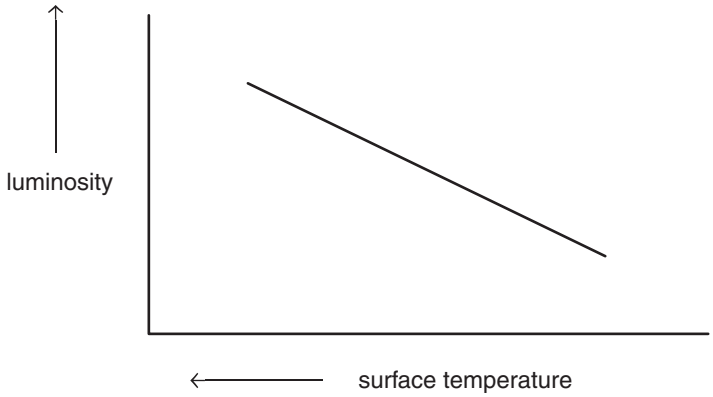
It is a measure of how fast the universe is expanding, or it can be used to calculate the age of the universe. 1 mark

Question 9

The galaxy is rotating about its own centre. 1 mark

Question 10

When a graph is plotted of the luminosity of stars against their temperature (or spectral class), 1 mark
most stars are positioned along a line, as shown in the sketch graph below. 1 mark



The stars that lie on this line are called main sequence stars. 1 mark

Question 11

The spectral analysis gives a maximum intensity at a particular wavelength of light. 1 mark
This wavelength can then be used to calculate the surface temperature. 1 mark

Question 12

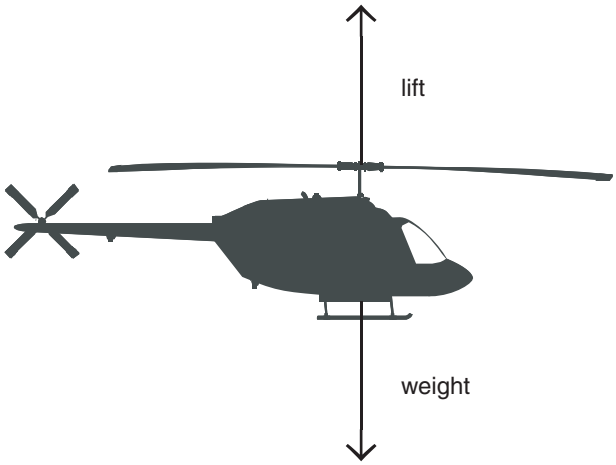
When looking at the spectrum of sunlight, dark bands can be seen. 1 mark
These bands show specific patterns corresponding to the presence of specific elements in the Sun, such as helium. 1 mark

Question 13

The fusion of light elements (e.g. hydrogen) into heavier ones (e.g. helium). 1 mark

Detailed study 2 – Aerospace

Question 1



2 marks

1 mark for two forces correctly labelled
1 mark for two forces equal in magnitude and opposite in direction

Question 2 C

2 marks

As the helicopter is not rotating, there must be zero net torque. This can only happen if both forces act through the helicopter's centre of mass.

Question 3

If the tail rotor failed, the main rotor would exert a non-zero torque on the helicopter. 1 mark

This would cause the whole helicopter to start spinning in the opposite direction to that of the main rotor. 1 mark

Question 4

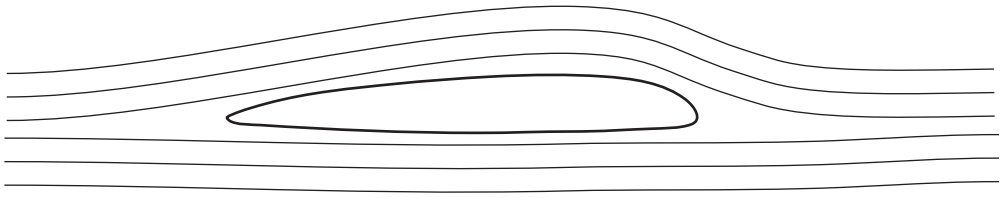
torque from main rotor = torque from tail rotor 1 mark

$6.0 \times 10^5 \text{ N m} = F_{\text{tail}} \times r$

$$F_{\text{tail}} = \frac{6.0 \times 10^5 \text{ N m}}{5 \text{ m}}$$

$F_{\text{tail}} = 1.2 \times 10^5 \text{ N}$ 1 mark

Question 5



1 mark

1 mark for cross-section of rotor blade showing longer pathway above it than underneath

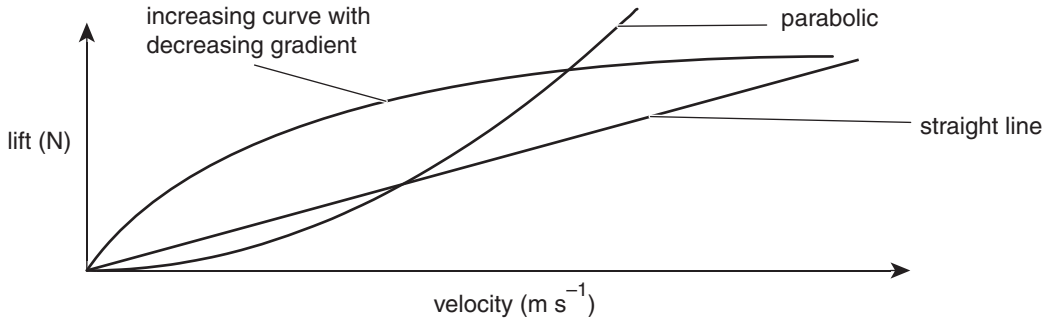
The air above the moving blade has a longer distance to travel than the air underneath the blade, and as a result the air above the blade is moving faster relative to the blade. 1 mark

The higher air speed means lower air pressure, and the pressure difference provides the lift force. 1 mark

Question 6

The board forces the air below it (and above it) to move downward. 1 mark
This change of momentum results in an equal but opposite impulse on the board, providing lift. 1 mark

Question 7



2 marks

1 mark for correct labels on axes
1 mark for ONE of the three curves shown on the graph above

Question 8

If the answer to Question 7 is a linear graph:
A faster bicycle would mean more displaced air, 1 mark
and therefore an increased impulse on the board. 1 mark
OR
If the answer to Question 7 is a curved graph with decreasing gradient:
Initially the lift increases with velocity, as a faster bicycle would mean more displaced air and an increased impulse on the board. 1 mark
At higher speeds, however, the lift no longer increases because turbulence increases. 1 mark
OR
If the answer to Question 7 is a parabolic curve:
Lift is proportional to the square of the velocity. 2 marks

Question 9

The angle of attack (or the size of the board or any other reasonable independent variable). 1 mark

Question 10

The lift would increase with small increases of angle. 1 mark
However, once a critical angle is reached the lift would start to decrease. 1 mark
If another independent variable is chosen, accept a reasonable prediction of the outcome of the experiment.

Question 11

power = $F \times v$

$15 \text{ kW} = F \times \frac{30}{12}$ 1 mark

$F = 6000 \text{ N}$ 1 mark

Question 12

three 1 mark
roll 1 mark
yaw 1 mark

Detailed study 3 – Alternative energy sources

Question 1

carbon dioxide 1 mark

non-renewable 1 mark

coal 1 mark

Question 2

$E = Pt$

$= 80 \times 1$

$= 80$ J 1 mark

Question 3

3% of 80 J = 2.4 J 1 mark

Question 4

If 15% of the electrical energy is converted to light, then to produce 2.4 J of light energy,

$\frac{15}{100} \times$ electrical energy = 2.4 J. 1 mark

$$\text{electrical energy} = \frac{100}{15} \times 2.4 \text{ J}$$

So the answer is 16 J. 1 mark

Question 5

One light saves $80 - 16$ J $= 64$ J in 1 s. 1 mark

1 year = 365 days = $365 \times 20 = 7300$ min = $7300 \times 60 = 438000$ s 1 mark

$438000 \text{ s} \times 64 \text{ J s}^{-1} = 2.8 \times 10^7$ J 1 mark

15 lights $\Rightarrow 15 \times 2.8 \times 10^7 = 4.2 \times 10^8$ J

$\frac{4.2 \times 10^8}{1000 \times 3600} = 117$ kW h 1 mark

Question 6

$E_{\text{gravitational}}$ (water) $\rightarrow E_{\text{kinetic}}$ (turbine) + heat $\rightarrow E_{\text{electrical}}$ (generator) + heat 3 marks

1 mark for three types of energy (gravitational, kinetic, electrical)
1 mark for correct location of each type of energy
1 mark for inclusion of heat

Question 7

gravitational potential energy = mgh

$= 8 \times 10 \times 0.1$ 1 mark

$= 8$ J 1 mark

Question 8

$E = VIt$

$= 1.5 \times 0.014 \times 95$ 1 mark

$= 2.0$ J 1 mark

Question 9

The gravitational potential energy was 8 J, and 2 J was converted to electrical energy.
6 J of energy is 'missing' from the system. 1 mark

Possible causes include:
water not passing through water wheel;
friction in water wheel;
heat generated by water wheel;
heat generated by generator;
some kinetic energy of water (since the water still has velocity after it hits the wheel). 1 mark

1 mark for any option from the list above (or any other reasonable answer)

Question 10

Possible answers include:

the efficiency of the model is much less than one would expect from a real power generation system;

the size of the hole determines the water flow and is difficult to model precisely;

the volume of water determines the pressure with which it exits the dam which is difficult to model precisely;

the water in the model needs to be replenished (i.e. there is no source of tidal energy);

the model does not include water at different pressures on either side of the turbine;

the model does not allow for the reversal of water flow through the turbine. 2 marks

1 mark for each option from the above list (or any other reasonable answer) to a maximum of 2 marks

Question 11

Energy source	Advantage	Disadvantage
Coal	A3	D2
Hydroelectricity	A1	D3
Wind	A2	D1

3 marks

1 mark for each pair of correct answers